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FLOWERING PLANTS,

AS ILLUSTRATED BY BRITISH WILD-FLOWERS.

By R. LLOYD PRAEGER, B.A.

IV.—FLOWERS AND FRUITS.

SOME of the leading characteristics of those all-important parts of plants which we call flowers were touched on in my last article, and the uses and more striking variations in shape and colour of the individual blossom were briefly dealt with. From the individual flower we may pass on to the consideration of inflorescences, or groups of flowers considered as a whole. Most of the wind-fertilized plants have their flowers arranged in more or less elaborate inflorescences—the beautiful compound panicles of many grasses furnish examples, and the dense flower-spikes of the Reed-mace and the sedges. In these cases, as already pointed out, the most advantageous position for the flowers to occupy is the apex of the stem, where they will receive the greatest amount of air and light, hence the minute flowers of plants such as the above-named are crowded together, often in enormous numbers, at the top of the upright stems. In insect-fertilized flowers, where conspicuousness is a desideratum, development has proceeded in two directions, and showiness may be due either to the great enlargement and coloration of parts of the individual flower, or to the grouping in a dense inflorescence of numerous smaller flowers—and, of course, all kinds of combinations of these conditions occur. In most of the plants in which the former extreme prevails, the flowers are solitary; the single blossom is sufficiently conspicuous to attract the attention of insects.

In the second photograph in my last article, the contrast between these two methods of "advertising" is clearly shown. Many instructive examples of the grouping of blossoms are to be found among our familiar wild flowers. Our commonest Orchids, such as belong to the genera *Orchis*, *Habenaria*, and *Listera*, have their blossoms arranged in a dense *spike*—a close-ranked pyramidal or cylindrical mass of flowers. But no one blossom covers or obscures another—a fact the more noteworthy when we recollect that each, as it expands, twists itself upside down. In the Teasel, each of the little lilac flowers which form the dense head is subtended by a stiff quill-like bract, which, projecting far beyond the blossom, forms an effective protection against grazing animals, while providing a convenient platform on which insects may alight. In the large order of *Umbelliferæ*, to which the Carrot, Hog-weed, and Parsley belong, a singularly conspicuous flower-mass is produced by means of an elaborate system of branching. The flowering stem divides at one point into a number of short radiating branches, of which the outer are the longer, so that the apices of all lie in a plane or slightly convex surface. If a flower were borne at each apex, a *simple* umbel would result; but in most of our commoner representatives of the order, each branch again divides into a similar series of branchlets, each of which bears a blossom. A large and conspicuous flat circular expanse of flowers is the result. Similar effects are produced in some other familiar plants by a less formal mode of branching—the Elder, for instance, furnishes a case in point. In some of the common *Umbelliferæ* an interesting feature may be noted. If the inflorescence of the well-known Hog-weed be examined, it will be observed that in those flowers of each umbellule or secondary umbel which are outermost, and especially in those which form the margin of the whole umbel, the petals on the outer side are considerably larger than those on the inner side. The petals of the inner flowers, and the inner petals of the outer flowers, could not increase in size without interfering with the neighbouring flowers; but where there is room for expansion, the plant has not lost the opportunity of rendering its blossoms more conspicuous. A similar feature may be noted in plants belonging to other orders—in the Field Scabious, for instance, where the outer flowers of the close head possess much enlarged corollas, which are quite unequal owing to the greater growth of the free side. In certain other familiar plants, this idea has been adopted to a much greater extent. Examine the inflorescence of the common Guelder-Rose, *Viburnum Opulus*. The greater number of the flowers of each large *cyme* have small corollas of a greenish white colour. But the marginal flowers have large white corollas, to produce which the essential parts of the flower—stamens and pistil—have been sacrificed. The flowers consist simply of a great corolla, and their object is to

direct the attention of insects, not to themselves, but to the adjoining perfect flowers, which are awaiting fertilization. This plant, in fact, keeps an advertising staff, whose sole duty is to draw attention to the wares offered by the comparatively inconspicuous normal flowers. In several species of Knapweed, notably in the handsome *Centaurea Scabiosa*, a similar division of labour is to be found. In other plants the leaves are pressed into the service as advertising agents. A notable example is furnished by the little Dwarf Cornel, *Cornus suecica*, found in mountain pastures. The umbel of small dark purple flowers is set in four conspicuous white petal-like leaves, which serve the purpose of the showy corollas of so many entomophilous flowers. In many of the *Compositæ*, which form so large an order, this differentiation of flowers exists in a marked degree. Of the Knapweeds we have already spoken. In the Daisy and many of its allies, the majority of the flowers are small, with a yellow regular corolla, enclosing male and female organs. The mass of yellow flowers is surrounded by a ring of flowers possessing female organs only, in which the corolla is white, and is prolonged on the free side into a conspicuous limb. In the allied Dandelion group, the corollas of all the flowers are enlarged on one side in this way, and point outwards from the centre. The accompanying photograph illustrates characteristic species of our two largest orders of grouped flowers—the Umbellifers and Composites.

FIG. 1.—Wild Angelica and Ox-eye Daisies. Illustrating the conspicuous effect produced by the grouping of numerous small flowers.

When flowering is over, and by means of insects or the wind or other agencies fertilization has been effected, there follows a period uninteresting to the casual observer, but of the greatest importance to the plant—the period of the growth and development of the fruit—that is, of the seed and its envelopes. In many cases, beyond the falling off or withering of the no longer useful showy parts of the flower, no external change is noticeable; but in many plants this is a period of vigorous growth—as in the Peas and Beans and many Cruciferous plants, and in plants with fleshy fruits, such as the Apple and Plum. The corolla, when its work of advertisement is done, usually falls; sometimes, as in our common Heaths, it remains dry and withered, and no doubt serves to protect the ripening fruit. The outer whorl, or calyx, is more persistent, and very frequently wraps about the young fruit, often growing as it grows, and forming a protective envelope. In many plants interesting movements may be noted between the periods of flowering and fruiting. In the numerous Pondweeds, for instance, which grow submerged or floating in water, the flowers are wind-fertilized, and during the period of blossoming the spikes of flower stand up erect above the water owing to curving of the flower-stem. When flowering is over, a reverse curvature submerges them, and the fruit is ripened below the surface, where it is less liable to misadventure from wind and wave. In the Water-Crowfoots, which are insect-fertilized, the same movement may be observed. A reverse movement is noticeable in various insect-fertilized land flowers. The buds of the Wild Hyacinth, Columbine, St. Dabeoc's Heath, are erect, but on expanding the bell-like flowers hang mouth downward, thus protecting the delicate essential organs from rain and cold. When flowering is over, the erect attitude is resumed, and the fruit ripens in that position. The Meadow Crane's-bill and Wood Crane's-bill are closely allied species, and much resemble each other in general appearance; but while the fruit of the one stands erect, in the other each fruit is pointed downward. What subtle difference between the mode of life or surroundings of the two plants has produced this change of posture since their derivation from a common ancestor, it is not easy to conjecture.

And now, as the result of this long life-history, the seed lies mature and ripe within the seed vessel—be it a leathery pod, or a woody box, or a juicy berry or pome; and the seed vessel is ready to separate from the parent stem, or to open and allow the seeds to escape. This is a critical time in the plant's history; quite as important as the period of flowering. On the successful sowing of the precious seed depends the life of the succeeding generation. What wonder then if we find, in connection with seed-dispersal, arrangements as elaborate and contrivances as ingenious as those which we have glanced at in connection with flower-fertilization.

In comparatively few cases do the seeds merely fall to the ground beside the parent plant, with apparently no means of further dispersal: the Buttercups and Wood Anemone appear to belong to this category. More frequently advantage is taken of some motive agent, which can assist the seed to a wider dissemination, that it may grow up clear of the impending shade of the parent, and of the exhausted soil which surrounds it, and by seeking fresh woods and pastures new, colonize the country and hold its own in the rough-and-tumble of overcrowded vegetation. These motive agencies are furnished by wind and water—notably by the former—and by animals. The simplest cases of wind-dispersal we see in the swaying of the herbs and trees as the breeze rustles through the woods and meadows. In many plants the ripe fruit or seeds lie in cup-shaped or saucer-shaped receptacles, out of which they would

not in calm air fall until the decay of the seed-vessel or the stem allowed the escape of the contents. The saucer-shaped receptacles of many of the *Compositæ* furnish a familiar example. Most of the plants of the Pink tribe *(Caryophyllaceæ)* have dry capsules, which open at the top when the seeds are mature, and of similar structure is the fruit of the Columbine, the Poppies, the Henbane. The fruit of the last named consists of a woody urn-shaped vessel, surrounded by the enlarged calyx, and closed at the top by a beautifully fashioned close-fitting lid, which, when the fruit is ripe, falls off, exposing the seeds within. All these plants have stiff upright stems. A gust of wind or the brushing past of an animal bends the stems, which spring back into their upright position, and in so doing project the seeds out of the seed vessel. Fruits arranged on this plan have aptly been called catapult-fruits. The wind similarly assists dispersal in the case of heavy-fruited trees, such as the Spanish and Horse Chestnuts. It is chiefly during gales that the fruit is torn from the branches, and flung by the swaying boughs clear of the umbrage of the parent. In these cases heavy fruits are a positive advantage, their momentum carrying them to a greater distance than a lighter body would reach. The majority of wind-dispersed plants, however, work towards the opposite extreme, and ensure transport by means of the extreme lightness of the fruits. The Orchids and Broom-rapes, for instance, produce an immense quantity of dust-like seeds; a single seed of the Lady's Tresses, *Goodyera repens*, is estimated to weigh no more than one-five hundred thousandth of a gram. A large number of other seeds or fruits, heavy in comparison with the foregoing, increase their buoyancy by means of wing-like or feathery appendages, which offer resistance to the air, and in consequence tend to fall slowly. Sometimes the seed itself bears a membranous wing. In other cases, as in the Ash, it is the envelope which encloses the seed that is flattened and wing-like. In the Sycamore, the wrapping of each seed is prolonged on one side into a wing like the blade of a propeller, and acts in a similar way, whirling round as the fruit falls, and retarding its passage to the earth, so that in a high wind the fruit may be carried some hundreds of feet. Note likewise the broad-winged fruit of the Elm. Of feathery appendages which serve the same purposes numerous examples occur to the mind—the Traveller's Joy, for instance, and the Pasque Flower, Reed-mace, and many grasses. The brown heads of the Reed-mace, when ripe, consist of a vast number of tiny seeds, each on a delicate stalk, clothed with long slender hairs, which spread as soon as they are set free, so that the head fluffs out into a mass of downy fruit of surprising dimensions, which the wind carries in all directions. Most perfect of all, we have the beautiful parachute fruits of the Dandelion and its allies, and of some other plants. In the Dandelion the seed is small and cucumber-shaped. Attached to its upper end is a delicate stalk, which branches in umbel-like fashion into an exquisite hemispherical parachute, which represents, morphologically, the limb or free upper portion of the altered calyx. These appendages and the surrounding general involucre are hygroscopic—affected by varying degrees of moisture. Should rain come on before the fruit is launched forth on the air, all the little umbrellas fold up and the involucre closes round them and keeps them dry. When the sun bursts forth, the whole elaborate structure expands again, a breath of wind severs the fruit from its slight attachment to the receptacle, and away it floats. In many cases the attachment of the seed to its parachute is also very slight, so that collision during its journey with an obstacle snaps the connection; the now useless parachute is cast off, and the seed drops, to seek some damp crevice in the earth where it may germinate.

Water plays a less conspicuous but not unimportant part in seed-dispersal. A river is, of course, continually bringing down seeds dropped into it from many plants along its banks, and in times of flood these are spread over adjoining low grounds. The seeds of many of the plants which fringe ponds and streams *float*, and even where no current exists, are drifted from one place to another by the wind. Eventually they sink, and germinate in the mud or sand which covers the bottom.

The part, intentional or unintentional, which animals take in the dissemination of seeds is nearly as important as that played by the wind. Just as the brightly-coloured flowers are designed to attract insect visitors, so the use of scarlet berries is to attract birds, which, by eating them, may scatter the seed. Numerous experiments have shown that the vitality of the seeds contained in these juicy berries is not impaired by their passage through the birds' bodies. Moreover, digestion in birds is extremely rapid, and the seeds may be expelled within an hour of being eaten. The bright colour and sweet juiciness of the Strawberry and Cherry and Apple, then, corresponds in function to the brilliant petals and store of honey of the flowers; both the plant and its animal visitor reap material benefit from the visits of the latter, and hence the relation continues, and, presumably, spreads. But in most cases the plant is not so dependent on the animal for the successful accomplishment of this function of its existence as in the case of fertilization. If no birds eat the fruit, it will fall to the ground—perhaps be carried by wind or water to some distance—and may there germinate. Only in a few cases are the visits of birds almost indispensable. The parasitic Mistletoe appears to furnish a case in point. Without the presence of birds, which eat the fruit and distribute the sticky rejected seeds about the branches, the chance of one of the heavy smooth berries reaching and adhering to the branch of even a neighbouring tree appears remote indeed. The advantage to these berry-bearing plants, of fruit which will retain its juiciness, and its hold on the fruit-stem, for a long period, is sufficiently obvious. Long after most of the summer plants have shed their seeds, the hips and haws, the black berries of the Privet and the white ones of the Snowberry, brighten the bare branches, furnishing a welcome winter food-supply to the birds, and thus securing a wide and efficient dissemination.

Thus far regarding fruits which lay themselves out to attract animals. Many other plants effect dispersal by making animals the unknowing and sometimes unwilling carriers of their progeny. The fruits and seeds of such plants are usually distinguishable by the hooks and barbs that they bear, the object of which is to attach the seeds to the body of passing animals. The large heads of the Burdock, with their hooked involucre-scales, are familiar to every child. Note that in this case it is the general involucre that bears the hooks. When ripe the whole head, containing many comparatively heavy fruits, is detached by adherence to the wool or hair of a passing animal. More often it is single fruits that bear hooked bristles, or barbed hairs. Many instances occur in our commoner plants—examine, for instance, the fruits of the Bur-Marigold, the Agrimony, Enchanter's Nightshade, Hound's-tongue. How effective a means of dissemination these hooked fruits furnish is

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a matter of common observation. I recollect picking over two hundred of the fruits of the Hound's-tongue off one stocking, after a stroll over the sand-hills that fringe the mouth of the River Boyne. Think how the sheep which graze on those sand-hills must carry the seeds far and wide. The experience of finding one's clothes full of the barbed fruits of the Enchanter's Nightshade on returning from an autumn walk in the woods is equally familiar to lovers of country rambles.

HOW ARCTIC ANIMALS TURN WHITE.

By R. LYDEKKER.

ALTHOUGH I have not the details of any one particular case before me, so many instances are chronicled in which the hair of human beings, under the influence of strong mental emotion due to terror or grief, has become suddenly blanched within a single night or some such period of time, that the occasional occurrence of such a phenomenon must apparently be accepted as a fact. Such a change is, of course, due to the bleaching of the pigment with which the hair is coloured, although we need not stop to enquire by what particular means this bleaching is accomplished; all that concerns us on the present occasion being to know that the hair in man may turn white in this manner under abnormal circumstances. And there appears to be evidence that under equally abnormal conditions a similar change may take place suddenly in the hair of the lower animals. This is exemplified by the well-known experiment made considerably more than half a century ago by Sir John Ross on an Arctic lemming—a small mouse-like rodent, which habitually turns white in winter, although dark-coloured in summer. In this instance the little animal was kept in a comparatively warm room till winter was well advanced, when it was suddenly exposed to a temperature of 30° below zero; a continued exposure to this and a still more intense degree of cold eventually resulting in its death, which took place within three weeks of the commencement of the experiment. In consequence of the conditions under which it had been kept, this lemming was still brown in mid-winter, when it ought to have been white. As a result of its first night's exposure, the fur on the cheeks and a patch on each shoulder became completely white, and by the end of the first week the whole coat had turned white. On examination, it was found that only the tips of some of the hairs had become blanched, and that these white-tipped hairs were longer than the rest of the coat, apparently owing to a sudden growth on their part in the course of the experiment. By clipping these long white-tipped hairs the animal was restored to its original brown condition.

Nothing is said with regard to any change of coat on the part of this lemming previous to the experiment, but it is probable that none occurred. It seems, however, to be clearly demonstrated that the tips of the hairs lost their colour by bleaching, induced by sudden exposure to the intense cold, and that the hairs thus blanched increased considerably in length in a very short period.

In spite of the very obvious fact that these changes occurred under extremely abnormal circumstances, it has been argued that Arctic mammals which turn white in winter do so normally by a similar blanching of the hair of the summer coat, and that the greater length of the winter, as compared with the summer dress of such white animals, is due to a lengthening of the individual hairs of the former.* Moreover, it has been inferred that the colour-change is directly under the control of the animals themselves. Quite apart from many other considerations, one weak point in this argument is that the hairs in the subject of the experiment were white only at their tips. It was doubtless assumed that had the experiment been continued over a longer period, the white would have gradually extended downwards till the whole hair became blanched. But had this been the normal way in which the change from a dark to a white coat is brought about, it is obvious that animals ought frequently to be captured in which the coat is in the same condition as that of the lemming. So far, however, as I am aware, no such condition has ever been described.

Moreover, it is perfectly well known that, apart from those which turn white in winter, a large number of animals have a winter coat differing markedly in colour, as well as in length, from the summer dress. The roebuck, for instance, is of a brilliant foxy red in summer, while in winter it is grey fawn with a large patch of pure white on the buttocks. And it is quite clear that the change from red to grey, and the development of the white rump-patch, is due to the shedding of the short summer coat and its replacement by the longer winter dress. Obviously, therefore, it is natural to expect that a similar change of coat takes place in the case of mammals which turn white in winter.

That the change in spring from a white to a dark dress is due to a shedding of the fur seems to be admitted on all hands, for it would be obviously quite impossible for long hairs to become short, or for white ones to turn brown. And even in animals which do not alter their colour in any very marked degree according to season the spring change of coat is sufficiently obvious. For the winter coat, owing to the long time it is worn and the inclemency of the season when it is in use, becomes much faded and worn by the time spring comes, and the contrast between it and the fresh and brilliant summer coat is very striking indeed. On the other hand, the summer coat is only worn for a comparatively short season, and that at a time of year when it does not become much damaged by the effects of the weather. Consequently no marked change is noticeable as the long winter hairs grow up through it; and it has accordingly become a common article of belief that, whether there is a change of colour or not, the long winter coat is produced by a lengthening of the summer dress.

Apart from the evidence of animals like the roebuck and many other deer as to the existence of an autumn change of coat, as deduced from a difference in colour, the fact of such a shedding of the fur is demonstrated by the circumstance that in many species, as, for instance, the mountain hare, the individual hairs themselves, as seen under a microscope, differ appreciably in calibre at the two opposite seasons of the year. In that species, for example, the hairs of the winter coat are of a much finer character than are those forming the short dress of summer, which are comparatively coarse and thick. Moreover, in spite of the natural tendency to believe in blanching on account of the aforesaid abnormal instances of turning white in a single night, there is abundant evidence to show that even in human hair the change from dark to white as age advances is

* *See* G. B. Poulton, "The Colours of Animals," chapter vii. (1900).

brought about by the replacement of dark hairs by white ones, and not by the bleaching of the former. In this case, however, the change, instead of being seasonal and sudden, is gradual and due to age. If the change was due to blanching, we should, of course, find some hairs which were partially white and partially brown (or black, as the case may be). And here it may be remarked that if such partially blanched hairs were met with, we should naturally expect to find that it would be the basal half which was white, and the terminal half which retained its natural colouring. In other words, precisely the reverse of the condition obtaining in Sir John Ross' lemming; thereby affording further presumptive evidence as to the abnormal condition of the change in that animal.

As a matter of fact, however, those of us who have reached an age when silver hairs have begun to make their appearance among the brown can easily satisfy themselves that such hairs are white throughout their entire length, and that a hair half white and half brown is quite unknown. From this we infer that the change from brown to white takes place in human beings by the gradual shedding of the dark hairs and their replacement by new ones from which pigment is entirely absent. So that normally there is no such thing as bleaching of individual hairs. The change is, indeed, precisely similar to that which takes place at the approach of winter in mammals that habitually turn white at that season, with the exception that, as a general rule, it is extremely slow and gradual, instead of being comparatively rapid, and also that the white hairs differ from their dark predecessors solely by the absence of colouring matter. Unfortunately, there is no subsequent replacement of the white hairs by dark ones!

The fact that the change from brown to white in the mountain hare (*Lepus timidus*) is really due to a change of coat and not to bleaching was known at a very early period to the English naturalist, Pennant; and the existence of this coat-change was likewise recognized by Macgillivray. It was not, however, till Dr. J. A. Allen, in a paper on the colour-change in the North American variable hare published in the *Bulletin* of the American Museum of Natural History for 1894, demonstrated by actual experiment the truth of Pennant's statement that the fact of the complete autumnal change of the coat in animals that turn white in winter was generally recognised by naturalists. So far as the spring change from the white to the brown dress is concerned, his conclusions are fully confirmed by Mr. G. E. H. Barrett-Hamilton, who communicated some interesting notes on the change in the European mountain, or variable hare to the *Proceedings* of the Zoological Society of London for 1899. The fact that the vernal colour-change is due to a shedding of the coat seems, however, as already mentioned, to have been much more generally admitted than was the case with regard to the autumnal transformation.

Dr. Allen arrives at the conclusion that both the autumn and the spring change take place periodically and quite independently of the will of the animal, and also that they are but little affected by phases of the weather, although they may be somewhat retarded or accelerated by the prevailing atmospheric temperature.

So far as the fact of the seasonal change being normally beyond the control of the animal in which it occurs, Mr. Barrett-Hamilton is in full accord with the American writer; but he goes somewhat further, and believes that it is quite uninfluenced by temperature, or at least by such variations of the same as may be met with in different parts of the area of the British Islands; and, as we all know, these are considerable!

As in the case of many other animals—deer, for instance—the change from the winter to the summer coat takes place very late in the season in the mountain hare in Scotland, specimens undergoing the change being often taken early in May. But the date of the spring change is no earlier in the South of Ireland, where the climate is much milder, although the amount of whiteness assumed in that district is very much less than in the north. This seems to demonstrate the contention that temperature has little or no influence on the change, so far as season is concerned.

That the animal has no control over the change from brown to white in autumn seems to be proved by instances referred to by Mr. Barrett-Hamilton, "in which variable hares transported from Scotland and from Irish mountains to southern and low-lying regions continued for some seasons to appear in the northern garb of snowy whiteness. This persistence of the habit of turning white, even in unsuitable conditions, together with the lateness of the moult, resulted frequently in the curious spectacle of a mountain hare running about in all its conspicuous arctic livery under the bright rays of an April or May sun. After a few years such imported hares, or more probably their offspring, ceased to turn completely white, and the breed assumed the appearance of the ordinary hares of the southern locality to which they had been transported."

It would, of course, be extremely interesting to ascertain whether such transported individuals ever do give up the practice of turning white in winter, or whether it is only their offspring that do so; but, in any case, it is clearly demonstrated that the habit is very deep seated and difficult to overcome.

Very curious is the circumstance that the mode in which the coat is changed in the variable hare at the two seasons of the year differs *in toto* as regards the parts of the animal first affected. On this subject, with one verbal change in the first sentence, we may quote from Dr. Allen, who writes as follows:—

"In the fall the change begins with the feet and ears, the sides of the nose and the front of the head, which often become radically changed before the body is much affected; while as regards the body, the change begins first at the base of the tail and extreme posterior part of the back, and at the ventral border of the sides of the body, working thence upward towards the middle line of the back, and from behind anteriorly, the crown of the head and a narrow median line over the shoulders and front part of the back being the parts last changed. In the spring the order of change is exactly the reverse, the moult beginning on the head and along the median line of the anterior half of the dorsal region, extending laterally and gradually to the ventral border of the sides of the body and posteriorly to the rump, and then later to the ears and down the limbs to the feet, which are the parts last affected, and which often remain but little changed till the head and body have pretty completely assumed the summer dress."

It is very hard indeed to conjecture any satisfactory reason for this remarkable difference.

The American variable hare ranges, at ordinary levels, about as far south as Massachusetts, that is to say, nearly to the latitude of Madrid, and throughout the whole of this extensive tract it turns white in winter. On the other hand, owing to the much milder climate of

western Europe, no colour-change takes place in the mountain hares of Ireland, while it is reported that in those introduced into Ayrshire and the neighbouring counties of south-western Scotland the change is much less complete and regular than in those inhabiting the northern parts of the country.

An impression appears to be prevalent that in the more northern portion of their range both the mountain hare and the ermine (or stoat) are white at all seasons, but this does not seem to be authenticated.

Observations are wanting as to whether the changes of coat and colour in the mountain hare bear any relation to the appearance and disappearance of snow, or whether they occur regularly at the same season of the year. In the case of the ermine in the Adirondack region of New York, Dr. C. H. Merriam tells us that in this animal the white livery is assumed only after the first fall of snow, while the resumption of the brown does not take place till the snow begins to melt. Unfortunately, he says nothing in regard to change of coat. The late Dr. Coues stated, however, that in the case of the ermine the bi-annual change of coat takes place at the same season, but that it depends upon the condition of the temperature at the time whether the new coat differs in colour from its predecessor. In other words, the change from brown to white might be due either to shedding the coat or to bleaching of the hair subsequent to such shedding. The case of the mountain hare is, however, strongly suggestive that the colour-change is in all instances coincident with the shedding of the coat.

It is, of course, quite evident that the assumption of a white winter livery by mountain hares and ermines living in regions where the snow lies on the ground for a considerable portion of the year is for the purpose of rendering such animals as inconspicuous as possible when in their native haunts. And, so far as we know, such a change is universal among the species named when dwelling in high northern latitudes.

There is, however, another animal inhabiting the north polar regions of both hemispheres in which the change to a pure white winter dress is limited to certain individuals. The species in question is the Arctic fox, of which the beautiful fur, in both the white and the blue phase, is now much affected by ladies. That both the white and the blue individuals of this species are in the winter dress, will be evident to every one who examines such furs carefully; the length and thickness of the hair being quite decisive on this point.

As it has been stated in several works that the white is the winter and the blue the summer phase of the Arctic fox, it may be well to quote from a letter written to me in answer to enquiries on this subject by Dr. Einar Lönnberg, of Upsala, whose observations are based on personal experience:—

"The 'blue' foxes," he writes, "are uniformly dark-coloured summer and winter, and do not change to white at any time. In the summer they are very dark—dark brown in fact; in winter they are also dark, but more bluish. The individuals which turn white in winter are during the summer ashy grey on the upper-parts and limbs, but have the tail, under-parts, more or less of the flanks, and the ears and muzzle white. The distribution of the grey and white is, however, subject to individual variation. The 'blue' fox is, in fact, merely an individual variety of the white one. Both breed together, and sometimes there are dark and light individuals in the same litter. A friend of mine observed on Bear Island a pair in which the female was white and the male blue. In Iceland it is stated that all the Arctic foxes are blue."

With this single exception it appears that the white and the blue phase are met with throughout the habitat of the species. In other words, the animal is "dimorphic," if it be permissible to apply this term to a case where the difference between the two phases of a species is restricted to coloration.

What makes the matter so puzzling is that if "blue" foxes are able to thrive during winter in a snow-clad country, what necessity is there for their fellows—and, indeed, for any species—to turn white at that season of the year?

THE WHITE NILE—FROM KHARTOUM TO KAWA.

AN ORNITHOLOGIST'S EXPERIENCES IN THE SOUDAN.

By HARRY F. WITHERBY, F.Z.S., M.B.O.U.

III.—THE COUNTRY AND THE PEOPLE.

MY last article* treated of the river and the stretches of grass and mud bordering upon it. Fringing the mud and stretching inland, for half a mile or so in most parts, but in some places for two miles, is a belt of wooded country. The trees composing this belt are chiefly of the acacia family, many of them being of a gum-bearing species, and under and around them is a thick under-growth of mimosæ, cacti, and other bushes. At the time of our visit the trees and shrubs, with few exceptions, were practically bare of leaves, so that, had it not been for the thickness of the trees there would have been but little cover.

Vegetation seemed entirely at a standstill, and the hot season might well be termed the winter in this district, especially as the general breeding season for the birds was over. Of the 141 species of birds which we identified only four or five appeared to be nesting. A small lark, which lived on the ground and continually sought the shade of some bush, made the neatest little nest in the dry mud by the river. The nest was a small shallow "cup" composed of dry grass and a few bits of cotton, while round the cup was a compact and neatly-arranged layer of particles of mud. Only one egg was laid. Two species of doves were also nesting. The nest and eggs of one‡ of them were much like those of our Turtle Dove. The other,§ which was a pretty little long-tailed bird, built an exceedingly slender nest even for a dove. It was round in shape and only 3½ inches in diameter. The two eggs were of a dark creamy colour. The young were most quaint objects lightly covered with whitish down. The smallest‖ of the many shrikes which we found was the only one breeding. I watched a pair at work on their neat chaffinch-like nest, which was placed in a fork of a horizontal bough some 30 feet up an acacia. The birds brought material at intervals of a minute or less during the considerable time I watched them. They invariably sat in the nest and turned rapidly round in it as they built in each mouthful of stuff which they brought. The outside of the nest they plastered with cobwebs.

As the dry season affects the foliage of the trees, so does the river influence their growth. When the river is at its greatest height many of the trees on its flat

* KNOWLEDGE, June, 1901.

‡ *Turtur ambiguus*, Boc.

§ *Oena capensis* (Linn.)

‖ *Nilaus afer* (Lath.)

banks are flooded half-way up their trunks. These trees are numerous and of a fair size, but they quickly decrease in number and height the further they grow from the water, and are soon replaced by tall bushes. The bushes struggle onwards, becoming gradually smaller and getting thinner, until they finally succumb to the want of water. Beyond, as far as the eye can see, stretches a flat desert with here and there a thorny leafless bush or a clump of withered grass, while near and far the deceitful mirage sets forth its enticing pools and ponds and lakes—a mock vegetation and a mock water in a merciless fiery land. This desert is formed for the most part of a grey and gritty cotton-soil, but in a few places it is of a true yellow sand.

At several points in our route there were "stations," where a large amount of wood is cut and collected for

Fig. 1.—Building a Square Brick Hut. The bricks in the foreground are baking in the sun.

the use of the steamers. Notwithstanding the scarcity of timber near Khartoum, and the fact that no other fuel is available, the gangs of natives employed to chop this wood were not then under sufficient supervision. The consequence was that much wood had been wasted and many fine trees ruthlessly maimed. We often passed a mile or two of stumps four or five feet high left in the ground, and so many of the best trees had been mercilessly lopped by the careless and ignorant natives, that near these wood stations it was often impossible to find shade for our tents. I was assured, however, at Omdurman, that the method of cutting the timber would shortly be improved.

The mimosa bushes, which form the dense undergrowth, are thickly covered with thorns of three to five inches in length, exceedingly sharp and strong, and of a dazzling white as though they were enamelled. As we ran short of pins we found these thorns exceedingly useful in packing our bird skins, but they made the country difficult to "negotiate." One was driven through my boot into the foot, another pierced the leg of one of my companions, and a third completely lamed a donkey for a month. The acacia trees, too, are plentifully provided with smaller but no less annoying thorns, and there are but two varieties of bushes without them.

Perhaps I have not drawn a very enchanting picture of the country it was our good fortune to work in, yet, notwithstanding its undoubtedly monotonous character and the lack of the pleasing colours and sun effects of Egypt, there is a peculiar fascination about this country near Khartoum. Its very extent and barrenness are a charm and confer an exalted idea of freedom on the traveller, while the scarcity of cover causes the naturalist to search through what little there is with an exaggerated delight and keenness.

The natives of these parts rarely lived under the trees. Every village of any importance was situated on the bare desert with no protection from the burning sun or scorching wind. In the vicinity of the villages there were always to be found large patches of ground used as cemeteries. The graves were the slightest mounds, having a stone, or a stick with a piece of white cloth tied to it, planted at either end, while a number of broken pitchers were placed bottom upwards here and there amongst the graves. The huts composing the larger villages were usually round in shape with conical straw roofs, the walls being built with bricks, which are burnt only by the heat of the sun. Some were square with flat roofs built in the same way as the majority of those in Omdurman, while a few had a rough verandah in front. All along our route, however, there was a great number of people living in very small huts which could be "struck" and moved about almost as easily as tents. These huts varied in shape and in the material with which they were constructed. Some were round with conical roofs and were entirely made of "dhura" straw, while a few were dome-shaped. The majority, however, were oblong, measuring about 6 feet broad and 7 or 8 feet long. These were not more than 5 feet high, and had flat roofs usually made of straw or matting, but sometimes of fodder, so that more than once a native sold us half his roof as food for our camels. Straw, cane matting, or cloth was used indiscriminately for the walls. The rough cloth used for this purpose is made of a mixture of goats' hair and sheep's wool, which is spun by the women on to a rough spindle in the same way that they spin cotton. A primitive loom is made on the ground with poles held in position by pegs driven into the sand, and the women while weaving squat down under a temporary sun-shelter. These movable dwellings were sometimes placed under trees,

Fig. 2.—A Dome-shaped Hut with a "Verandah." The hut is made of matting and cloth.

but generally in the open, and there were seldom more than six or eight together. The natives inhabiting them were very shy, and twice when we pitched our tents near an encampment the people were soon busy

rolling up the matting and cloth forming the walls of the huts, and in a few hours disappeared, carrying away their roofs by the four corner poles, their rolled-up walls, and all their goods and chattels. When asked why they moved away from us they gave no reason beyond remarking that they objected to our tents being near them.

In two or three places we found natives living in a much rougher sort of hut, built under very thick bushes which had been cut out in the middle and thickened on the outside, thus forming natural "Zareebas."

The reason for such diversity in dwellings lies in the mixed character of the population of this stretch of country. Arabs and blacks of many tribes inhabit it, and although rather thinly populated, the people were so evenly distributed along our route that we were scarcely ever out of sight of a native. At the time of our visit the men were enjoying idleness, but the women were always hard at work carrying water or grinding corn. The corn is placed upon a wide and heavy stone and is then ground with a smaller stone, which is rubbed and rolled backwards and forwards. The stones wear away rapidly, and a family must actually consume a goodly number in a lifetime. The boys are also kept busy shepherding the goats and sheep, which are in thousands all over the country. These animals are very rarely slaughtered and are kept merely for their milk. In the wet season, of course, conditions are entirely changed, and the men are busily employed growing "dhura," maize, cotton and other produce. At the end of the dry season food becomes so scarce that the goats are fed upon the roots of the grass, the grass being hoed up, and the roots beaten soft with short wooden clubs.

Near the large villages we found the natives decidedly independent and difficult to get on with. In the smaller villages and isolated communities the dress, or rather the greater want of dress, at once showed the people to be of a more unsophisticated nature. They greeted us with many salaams and much kissing of

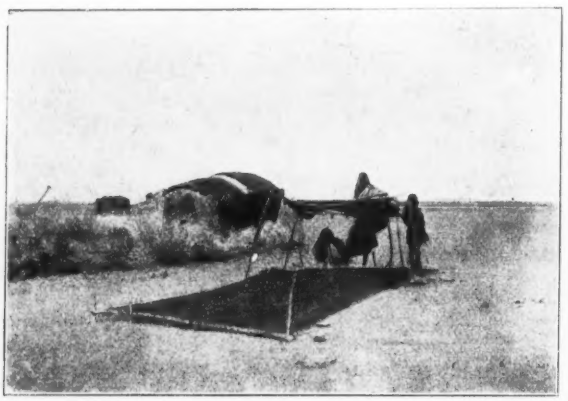


FIG. 3.—A Native Loom.

hands, and were more willing to give us such supplies as they could, but very little work could be got out of them.

At every camp we harangued the "Sheikh" of the nearest village and asked him to procure us animals for our collection, but we stipulated that they should be brought in alive and uninjured. We offered varying rewards, but at only one camp did the natives show any interest or take any trouble to earn the reward. At this camp, near a rocky hill named Gebel Auli, the natives brought us a number of bats and some rather rare hedgehogs, caught in the caverns on the hill. The bats were brought by a boy who appeared with his shirt bulging out and held up to his neck. Out of the shirt were extricated, amidst considerable amusement and excitement, half-a-dozen live bats with long and very sharp teeth, which were more than once used with great effect. The bats were swarming in the cracks and caverns of Gebel Auli, and their squeaking could be heard at a considerable distance. The natives poked long sticks into the cracks and out flew the bats, which

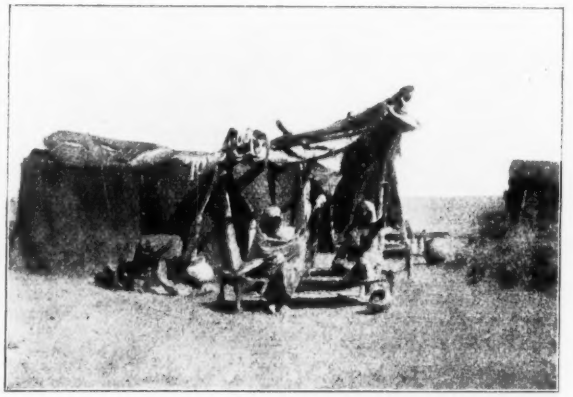


FIG. 4.—A Movable Hut made of Matting. The woman on the left is grinding corn, while the two seated on the "angarib," or native bedstead, are spinning.

were knocked down with cloths. The hedgehogs which were brought to us from this same hill were exceedingly pretty little beasts with dark spines and white hair. On them we discovered some elegant yellow fleas, which I gave to Mr. Charles Rothschild, who collects these parasites. He proclaims them a new species, and has done me the honour of naming them *Pulex Witherbii*!

In general, however, the offer of a reward for animals would produce great keenness among the natives for only a day or so. They would bring in any number of the common rats of the country and, although we stipulated for live animals, every bone, skull, or bit of skin that could be found would be brought in the hope of reward. But when they found that we needed no more of the rats that swarmed in their huts, these very lazy natives returned to their normal occupation of sleeping and eating and refused to hunt any further. This seems extraordinary, because luxuries to a certain extent can now be bought for money in the markets of all the larger villages through which we passed.

In the days of the Khalifa it was rather a disadvantage for a man to become prosperous. The tyrant would soon hear of it, sweep down upon him and carry off his flocks and corn. As several natives said to us when we asked them why they refused the money we offered for goats' milk: "The Khalifa never took the milk, he always took the goats unless they were driven away and hidden. Now you come and only want the milk and offer to pay for that!" No doubt they think the English fools.

Although singularly uninquisitive the natives provided one of the trials of collecting by their ubiquity. One could never be sure on shooting at a bird whether

a concealed native would not rise from behind a bush in the line of fire at the moment.

We never actually shot anyone, however, although there were many narrow shaves. The traps which we set for mammals, although carefully concealed, seldom brought us profit. Goats tramped over them, natives stole them, presumably for the copper wire of which they were made, and dogs dragged them away for the meat with which they were baited.

These dogs, as is usual in Africa and the East, are never fed, and consequently become very bold and expert thieves. I had the misfortune to be ill in our first camp, and the dogs used to creep into my tent at night and drink the milk at my bedside.

Another visitor, but a pleasing one, appeared in the daytime. This was a little bird—the Lesser Whitethroat¶—a summer visitor to England, and exceedingly numerous during our winter and spring on the White Nile. The Whitethroat came to my tent for water, a bucket of which was kept near my bed. On the very first day of my illness this bird found out the water and came into the tent, perching on the bed or my arm. It stayed there most of the day, and whenever I splashed my hand in the water it would hop down my arm and suck the drops of water from my finger tips. The bird was always thirsty, and although the river was quite near it seemed to prefer to drink in this way, and so I was amused by this delightful little bird all through the heat of the day. I missed it much on moving from this camp.

The extreme dry heat of the country affects the birds perhaps more than other animals. All the land birds, large and small, almost always kept their mouths open as though gasping in the heat. Yet they sing, some of them as beautifully as our songsters, and seem as happy as birds usually are. We used to take advantage of their propensity to drink as a means to entice them within range of the camera. A tin of water was placed in the sand at a few yards distance from the camera, which was kept focussed, and ready for action whenever a bird came to drink. In this way many interesting photographs were apparently secured, but alas, on development, all my "photographs" proved complete failures. Messrs. Dallmeyer had carefully fitted up for me one of Messrs. Watson & Sons' "Gambier Bolton" cameras with telephoto lenses. The camera proved strong enough to resist the heat and the camels, and would no doubt have worked very well had I taken plates and risked the great chance of their being broken. I chose, however, to take films, which became seriously affected by the great heat, and were, moreover, defective in the making as regards the emulsion. For this ruinous defect the maker deserves to be named. Such a defect could, of course, be guarded against by testing each batch of films before starting, but the fogging due to the heat cannot be avoided. I think it wise to mention this because, although I am well aware that films are often perfectly successful in very hot climates, they are as often not, and the successes are well advertised while the failures are seldom reported. Half the number of plates in such a climate would be more certain to yield success if very carefully packed than twice the number of films.

Only the common and boldest birds came down to the tin of water to drink and be photographed. Of these a species of Bulbul,** a bird a little larger than a Robin, with a black head, a brown back, and a white breast, was the most confiding and usually the first to try the experiment. One or two of these birds were always in the trees over our camps, and their pleasing flute-like notes, almost exactly syllabled by the words "tit-willow," were continually to be heard.

¶ *Sylvia curruca* (Linn.) ** *Pycnonotus arsinœ* (Hempr. et Ehr.)

THE BRIGHTNESS OF STARLIGHT.

By J. E. GORE, F.R.A.S.

IT is probably a matter of common observation that on a clear moonless night it is never absolutely dark, even at midnight; a certain amount of light is given by the stars. What does this light amount to in terms say of full moonlight? Miss Clerke, in her "System of the Stars," gives the light of all stars down to 9½ magnitude as about 1-80th of full moonlight. M. G. l'Hermite found starlight equal to 1-10th of moonlight, but this estimate is evidently too high. The difference between a bright moonlight night and one illuminated by starlight alone is very considerable.

Let us make an attempt to estimate the total amount of starlight by computing the light emitted by all the visible stars down to the faintest point visible in the largest telescopes, like those of the Yerkes and Lick Observatories. The data available for this calculation are rather uncertain, but an approximation to the truth may perhaps be possible.

To express the total amount of starlight in terms of the light of a star of zero magnitude, like Arcturus, and thence in terms of moonlight, let us assume—as is now admitted by most authorities on the subject—that the total number of the visible stars is about 100 millions. Let us also assume that the "light ratio" is 2.512 (now accepted by all astronomers)—that is, that a star of zero magnitude gives 2.512 times the light of a star of the 1st magnitude, a star of the 1st magnitude 2.512 times the light of a 2nd magnitude star, and so on. To enable us to make this calculation it will be necessary to estimate the number of stars of each magnitude down to the 17th magnitude, which is about the faintest visible in the great Yerkes telescope. Dr. Gould, in his *Uranometria Argentina*, gives the following formula for computing the total number of stars visible in both hemispheres to any given magnitude, m.

$$\Sigma_m = 1{\cdot}0051 \times (3{\cdot}9120)^m$$

From this I find the following:—

Magnitude.	No. of Stars.	Magnitude.	No. of Stars.
To 1.0 inclusive	3·93	To 10.0 inclusive	843,718
„ 2.0 „	15·74	„ 11.0 „	3,283,876
„ 3.0 „	60·17	„ 12.0 „	12,911,448
„ 4.0 „	235·4	„ 13.0 „	50,511,900
„ 5.0 „	920·9	„ 14.0 „	197,602,545
„ 6.0 „	3602·5	„ 15.0 „	773,021,071
„ 7.0 „	14,093	„ 16.0 „	3,024,057,632
„ 8.0 „	55,131	„ 17.0 „	11,830,114,720
„ 9.0 „	215,674		

From this it will be seen that the formula gives for the fainter stars numbers enormously too large. For the brighter stars, viz., those of the 6th magnitude, the numbers seem to be rather small. Houzeau, who observed himself all the stars visible to the naked eye in both hemispheres, gives the following figures:—

Magnitude.	No. of Stars.
1	20
2	51
3	200
4	595
5	1213
6	3640
Total	5719

Accepting those figures, and adjusting the remaining magnitudes to suit a total of 100 millions down to the 17th magnitude, we obtain the following table:—

1. Magnitude.	2. No. of Stars.	3. Light of each Star in terms of zero mag.	4. No. of equivalent zero Stars.	5. Remarks.
Above zero	2	—	7	Sirius and Canopus.
Zero mag.	1	1	1	Arcturus.
0 - ½	5	$\frac{1}{(2{\cdot}512)^{\frac{1}{2}}}$	4	Capella, Vega, α Centauri, Rigel and Procyon.
½ - 1½	13	$\frac{1}{2{\cdot}512}$	5	
1½ - 2½	51	$\frac{1}{2{\cdot}512^{2}}$	8	
2½ - 3½	200	$\frac{1}{2{\cdot}512^{3}}$	13	
3½ - 4½	595	$\frac{1}{(2{\cdot}512)^{4}}$	15	
4½ - 5½	1213	$\frac{1}{2{\cdot}512^{5}}$	12	
5½ - 6½	3640	$\frac{1}{2{\cdot}512^{6}}$	14	To this magnitude, 6½, the numbers of the stars in each class have been assumed from Houzeau's results. The numbers in the fainter magnitudes have then been roughly adjusted so as to make the total about 100 millions. This may seem a rather arbitrary proceeding, but there is evidence to show that the stars really "thin out" below the 11th magnitude.
6½ - 7½	15,000	$\frac{1}{2{\cdot}512^{7}}$	24	
7½ - 8½	50,000	$\frac{1}{2{\cdot}512^{8}}$	31	
8½ - 9½	160,000	$\frac{1}{2{\cdot}512^{9}}$	40	
9½ - 10½	628,000	$\frac{1}{2{\cdot}512^{10}}$	63	
10½ - 11½	2,440,000	$\frac{1}{2{\cdot}512^{11}}$	97	
11½ - 12½	6,000,000	$\frac{1}{2{\cdot}512^{12}}$	95	
12½ - 13½	10,000,000	$\frac{1}{2{\cdot}512^{13}}$	64	
13½ - 14½	14,000,000	$\frac{1}{2{\cdot}512^{14}}$	35	
14½ - 15½	18,000,000	$\frac{1}{2{\cdot}512^{15}}$	18	
15½ - 16½	22,000,000	$\frac{1}{2{\cdot}512^{16}}$	9	
16½ - 17½	27,000,000	$\frac{1}{2{\cdot}512^{17}}$	4	
Totals ...	100,198,093		559	

It will be noticed that the numbers in column 4 of the above table rapidly diminish for the fainter magnitudes. If there were 100 millions of stars of the 20th magnitude their combined light would be only equal to that of a single star like Arcturus. From this it is clear that the light of all the stars below the 17th magnitude may be safely neglected.

In addition to the stars there are a large number of nebulæ scattered over the surface of the heavens, but the majority of these are such faint objects that their combined light must be inconsiderable. Assuming a total number of 120,000 nebulæ and an average brightness for each equal to that of a star of the 8th magnitude, we have their combined light equal to 30 stars of zero magnitude. Hence the total light of all the stars and nebulæ in both hemispheres would be equivalent to that of 589 stars of zero magnitude like Arcturus. This estimate, of course, includes the Milky Way.

Now to find what fraction this is of moonlight we must consider some estimates which have been made of sunlight and moonlight. Huygens in the 17th century found the sun 756,000,000 times brighter than Sirius; Michell in 1767 found 9,216,000,000; Wollaston in 1825-6, 20,000,000,000; Von Steinheil in 1836, 3,840,000,000; G. P. Bond in 1861, 5,970,500,000; and A. Clark found 3,600,000,000. The mean of all these rather discordant measures is:—

Sun's light = 7,230,000,000 times light of Sirius. Modern photometric measures make Sirius about four times the brightness of Arcturus, and hence we have

Sun's light = 28,920,000,000 times light of zero star.

Comparing sunlight with moonlight, Bouguer found the sun 300,000 times the brightness of full moonlight; Euler found 374,000; Wollaston 801,072; G. P. Bond 470,980, and Zöllner 618,000. The mean of these is 512,810, but Zöllner's estimate of 618,000 is the one now generally accepted. Assuming this value, we have—

$$\text{Moonlight} = \frac{28{,}920{,}000{,}000}{618{,}000}, \text{ or}$$

Moonlight = 46,800 times light of star of zero magnitude.

$$\text{Hence starlight} = \frac{589}{46{,}800} = \frac{1}{80} \text{ of moonlight.}$$

This result gives for *one* hemisphere (which is all that is visible from one place at one time)

$$\text{Starlight} = \frac{1}{160} \text{ of moonlight,}$$

And this is probably not far from the truth.

An examination of the table will show that the combined light of the stars below 6½ magnitude is considerably greater than the light of those above that magnitude, so that if all the stars visible to the naked eye were extinguished we should still have nearly the same amount of starlight.

CONSTELLATION STUDIES.

By E. WALTER MAUNDER, F.R.A.S.

VIII.—THE ARCHER AND THE WATER-BEARER.

THE constellation of Sagittarius, when on the meridian, is almost entirely above our English horizon, but it lies so low that it is perhaps less familiar to us than any other of the zodiacal signs, for though Scorpio does indeed lie lower still, its brilliance has made it better known. Still, there is no difficulty in recognizing it on a very clear night, at its culmination, which takes place at midnight at the end of June. The old rhymester directs us—

"From Deneb, in the stately Swan, describe a line south-west
Through bright Altair in Aquila, 'twill strike the Archer's breast."

Or, most strictly speaking, his shoulder, marked by the bright star, Sigma. A little in advance of Sigma are five bright stars in an undulating line on the eastern branch of the Milky Way, which here suffers one of its numerous divisions. Proceeding from the most northerly of these downwards, they are lettered Mu, Lambda, Delta, Epsilon, Eta, and mark the position of the Archer's Bow. A pair of stars, both bearing the letter Gamma, a little in advance of Delta, marks the point of the Arrow which the Archer is discharging at the Scorpion, whilst Zeta, a bright star a little below Sigma, marks the wing of the Arrow. A little triangle of stars, Xi, Omicron, Pi, mark the neck of the figure, and practically exhaust the list of its brighter stars. Alpha and Beta, the latter a wide double star to the eye, are in one of the hind legs of the Man-horse, but are below our English horizon.

But though Sagittarius is not a distinguished constellation, viewed as a whole, it is very rich in objects of the greatest interest in opera-glass or telescope. Mu, the upper horn of the Bow, is the centre of a region

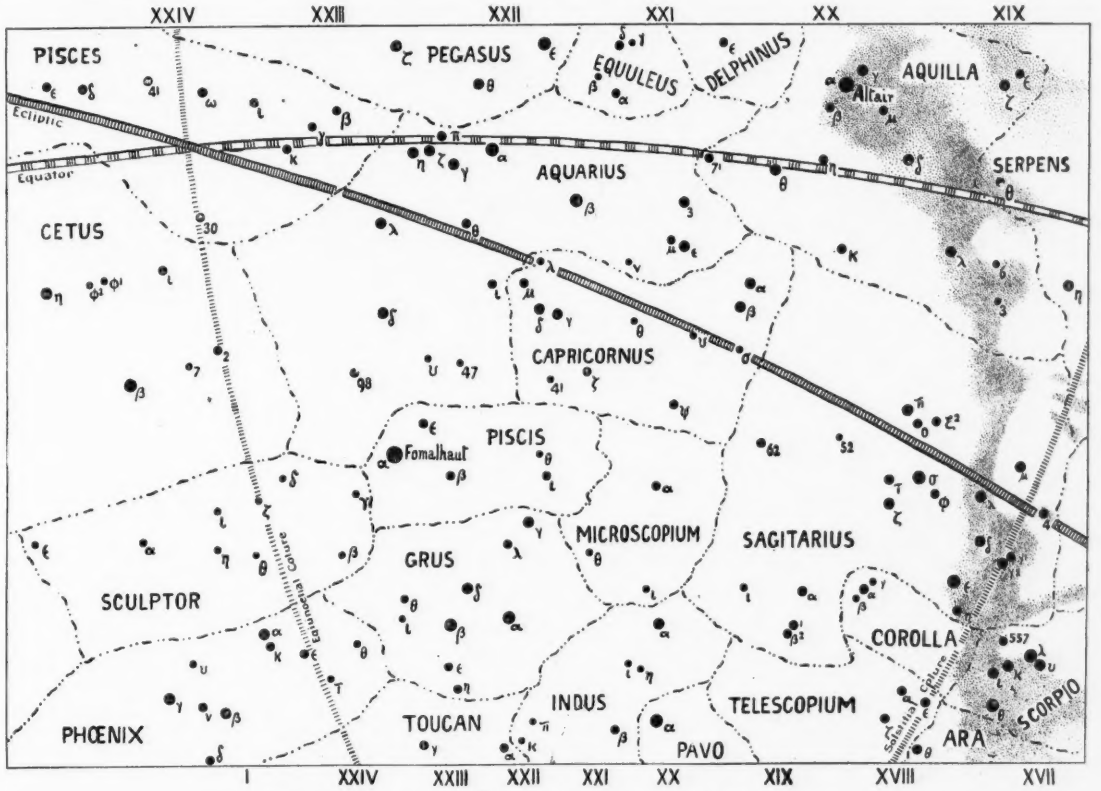
as rich in star clusters as the nebulous region in Virgo is in nebulæ. A wonderful object, number 8 in Messier's catalogue, forms a rhomboid with Mu, Lambda and Delta. North of Mu lies number 24 of the same catalogue, a star cluster quite unlike Messier 8, but almost as attractive. Passing upwards in the same straight line, we come to Messier 18, then Messier 17, the famous "horse-shoe" nebula, and a little further off, Messier 16. These clusters are the principal objects in the little modern constellation, Scutum Sobieski, a little asterism which Hevelius devised to celebrate the valiant John Sobieski, king of Poland, and deliverer of Europe from the Turk. Proctor and some other modern map makers omit the constellation entirely, and for the sake of simplicity it is well that it should be so. As designed, it filled a small triangular space between Serpens, Aquila and Sagittarius. It was practically entirely enclosed within the borders of the Galaxy, and contains but a single notable star, the variable R. Scuti; but its wealth of telescopic stars, clusters and nebulæ is most remarkable. Sir William Herschel estimated that in five square degrees of space it contained one-third of a million of stars. Of its clusters the most wonderful is just visible to the naked eye, and is Messier 11, the "Flight of Wild Ducks," on the north-eastern border of the constellation.

The fore-feet of Sagittarius are often not shown in the designs of this constellation, the place where they should come being occupied by the Southern Crown.

"Other few,
Below the Archer, under his fore-feet,
Led round in circle, roll without a name."
(Brown's *Aratus*.)

The constellation lies below our English horizon, with very little to mark it from any point.

The next zodiacal constellation to Sagittarius is Capricornus, small and easily found. Just as Sagittarius is a centaur or man-horse, so Capricornus is almost invariably a goat-fish. The goat has usually been explained as signifying the sun at the winter solstice, seeing that after that season has passed, the sun begins again to move upward in the sky; the rock-haunting goat or ibex being adopted as the symbol of the climbing motion of the sun, whilst the fishtail pointed to the rains and floods of midwinter. We know, however, that the constellations were mapped out many centuries before the winter solstice fell in Capricorn, and that the explanation, however ingenious, was but a late guess, made when all actual recollection of the meaning of the sign had been lost.



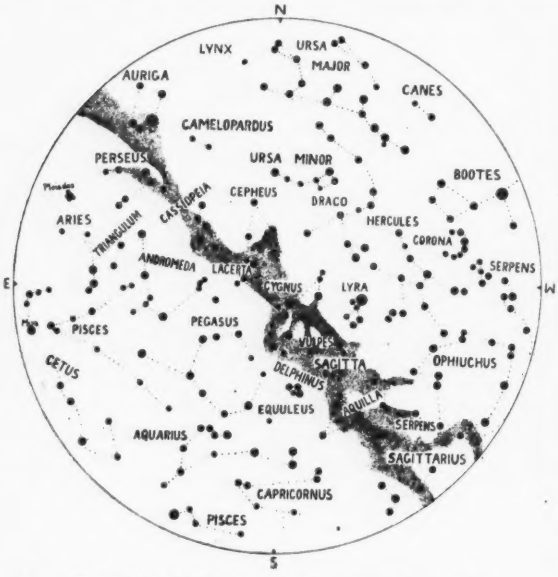
Star Map No. 8; The Region of the Archer and the Water-bearer.

Capricorn may be found by drawing a straight line from Vega through Altair. Omega Capricorni lies just as far below Altair as Vega lies above it, and marks one knee of the kneeling goat. Psi, immediately above, lies almost on the straight line from Altair, and Alpha and Beta, which mark the root of the horns and the eye of the animal, are but little in advance of the line, only considerably higher up. Alpha is Algedi, which simply means "the goat"; Beta is Dabih, "the slaughterer." The first of these stars is a visual double, and it is interesting to note that it has become so comparatively recently. The two stars have no real connection with each other, and their proper motion is carrying them apart by something more than a minute

of arc in a thousand years. Beta Capricorni is also a beautiful double in the opera-glass, the fainter star being of a sky-blue tint. The only other stars of any great brightness in the constellation are Zeta, Gamma and Delta, which mark the fishtail. Delta is indeed the brightest star in the whole asterism, and bears the name Deneb Algiedi, the "tail of the goat." Following Zeta by about the same distance that Alpha is from Beta, the opera-glass will show as a faint point of light 30 Messier, a large cluster of remarkable richness.

"Down from bright Vega, cast your glance across the Dolphin's space
Then just as far again you'll find the Waterbearer's place."

Aquarius is one of the straggling constellations, and pretty nearly overwhelms Capricornus. He has been figured from time immemorial as a man pouring out a stream of water from a pitcher; but for some reason, which is now lost to us, his right arm is stretched backwards to the fullest extent possible so as to reach over almost the entire length of Capricorn. The figure is by no means clearly marked out in the main. The stream from the pitcher can be traced in the number of faint



The Midnight Sky for London, 1901, August 5.

stars in the eastern portion of the constellation, which lead downward in wavering curves to Fomalhaut, a star of the first magnitude and one of the four ancient Royal Stars. Dwellers further south can recognize Fomalhaut without any difficulty, since Achernar lies just mid-way between it and Canopus. But at 2 o'clock in the morning in the present time of the year it is impossible for English observers to mistake the star; it lies low down on our southern horizon without any serious competitor near it.

Its name Fomalhaut simply means "the Fish's Mouth," for strangely enough through all the long centuries that the starry symbols have come down to us, Aquarius has always been shown as pouring forth his stream of water into the mouth of a fish; surely the strangest and most bizarre of symbols.

Fomalhaut, Beta Capricorni and Alpha Aquarii form the points of a triangle which is nearly equilateral. Alpha Aquarii is known as Sadalmelik, the "fortunate star of the King"; Beta Aquarii, one-third of the way from Alpha Aquarii to Beta Capricorni, is Sadal Sud, "the luckiest of the lucky," supposed to refer to the good fortune attending the passing of winter. Alpha and Beta mark the two shoulders of the waterpourer, and three bright stars near Alpha, Gamma, Eta and Pi, with a fourth, Zeta, almost in the centre of the triangle, mark the body of the pitcher from which Aquarius is pouring.

The outstretched arm of Aquarius is marked by a slightly curved line of stars extending from Beta Aquarii to Alpha Capricorni. Two fairly bright stars, Mu and Epsilon, near Alpha Capricorni, give the place of the Waterbearer's hand. In the middle of the arm is Nu, a much fainter star, and about a degree and a half preceding it. Just barely within the power of an opera-glass to reveal it as a faint point of light, is one of the most wonderful of the planetary nebulæ. Midway between Alpha and Beta Aquarii, but above the line joining them, is M. 2, in the head of the Waterpourer; "a heap of fine sand" where each grain is a sun.

Those who have the opportunity of observing from southern or equatorial regions, will find the brightest and most easily recognized of all the new constellations due to Dircksz Keyser, just south of Piscis Australis, the constellation of which Fomalhaut is the chief star. This is Grus, the Crane, and five bright stars distributed at equal distances along a gentle and regular curve, whilst a bright second magnitude star precedes them, form its principal characteristics. The Microscope, interpolated by Lacaille between Sagittarius and Piscis Australis, and the Sculptor's Tools, now more generally known as the Sculptor, which he added below Aquarius, are as destitute of features of interest as the designs are of appropriateness to their celestial surroundings.

PHOTOGRAPHS OF THE NEBULÆ H V. 32 ORIONIS, H IV. 2 MONOCEROTIS, H IV. 28 CORVI, AND H I. 139 (M. 61) VIRGINIS.

By ISAAC ROBERTS, D.SC., F.R.S.

NEBULA H V. 32 ORIONIS.

R.A. 5h. 1m. 57s. Decl. 3° 29′·4 South. Epoch 1900.

Scale—one millimètre to twelve seconds of arc.

REFERENCES.

N.G.C. 1788. G.C. 1005. *h* 347. H V. 32. Rosse, *Obs. Neb. and Cl.*, p. 46.

The photograph was taken with the 20-inch reflector on February 28th, 1899, between sidereal time 5h. 44m. and 8h. 4m., with an exposure of the plate during two hours and twenty minutes, and it shows the nebula to be cloud-like in form and extending in *north preceding* to *south following* direction with fainter nebulous extensions towards the *north following*. There are dark areas which indicate that we can see, through gaps in the nebulosity, into the lightless void beyond it; the larger gap being on the south and *south preceding* sides, with a solitary faint nebulous star-like condensation near its centre.

One star of about 9th magnitude with a *comes* of 13-14 magnitude are apparently involved in the northern part of the nebula, and in the *south following* end is an apparently nebulous star of about 10-11 magnitude; there are also seven or eight stars of less brightness than 13th magnitude contiguous to the nebulosity; some of them are

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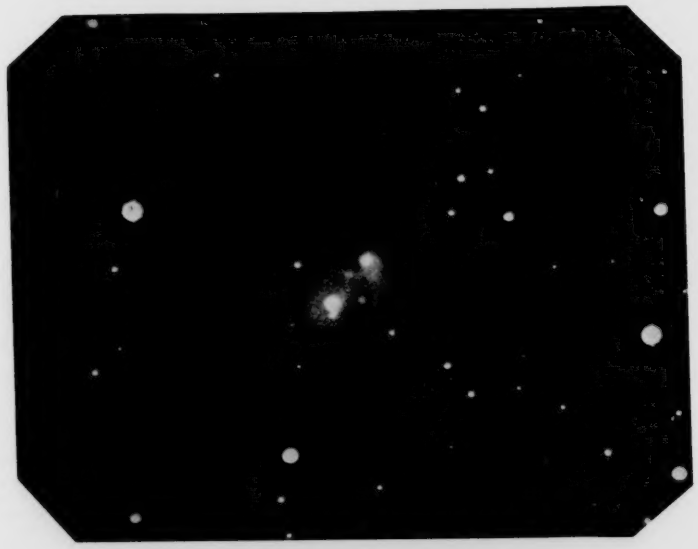
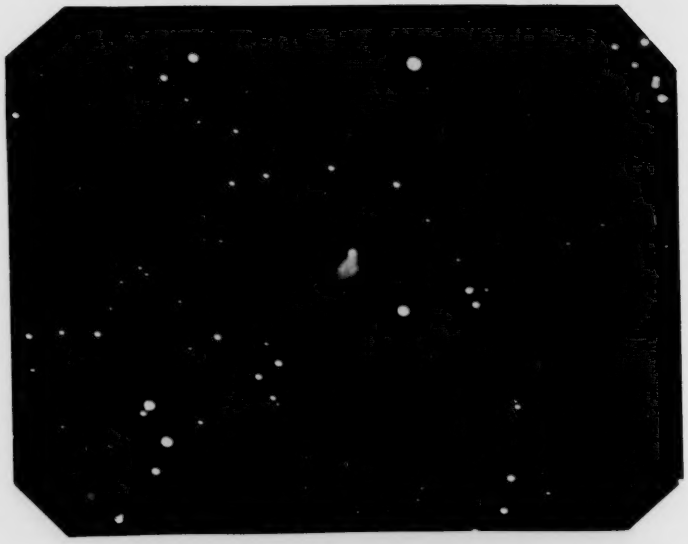
PHOTOGRAPHS OF NEBULÆ.

By ISAAC ROBERTS, D.Sc., F.R.S.

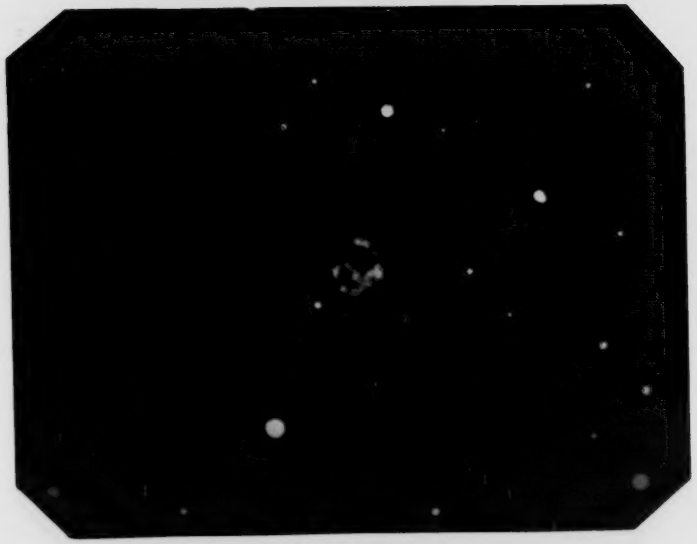
S.



P. ℍ V. 32 Orionis.

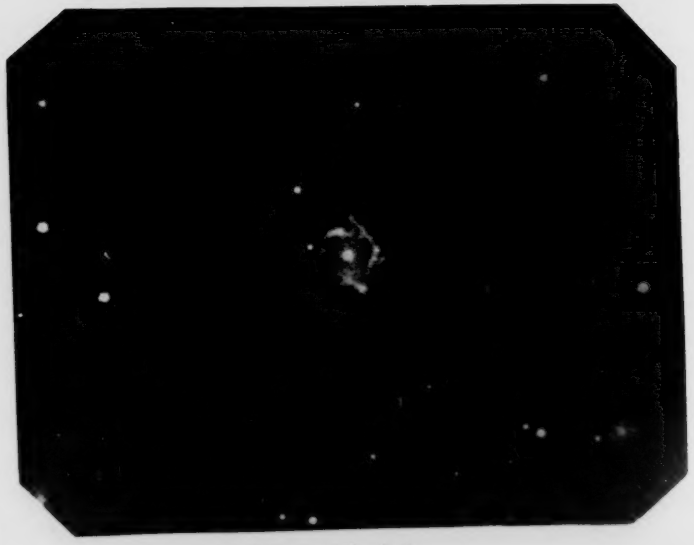


ℍ IV. 2 Monocerotis. F.



ℍ IV. 28 Corvi.

N.



M. 61 Virginis.

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involved in it. The brighter stars may not be involved in the nebula but seen in alignment with it.

There is no indication that the nebula has great depth, but rather that it resembles a relatively thin cloud which can partly be seen through, and the two bright stars apparently involved in it have projections of nebulous matter extending from them which somewhat resemble the projection from the star *Electra* in the *Pleiades*. In order to see these appearances clearly it is necessary to examine the original negative, for they are too faint to be reproduced on paper prints.

NEBULA H IV. 2 MONOCEROTIS.

R.A. 6h. 33m. 42s. Decl. 8° 49′·3 North. Epoch 1900.

Scale—one millimètre to twelve seconds of arc.

References.

N.G.C. 2261. G.C. 1437. *h* 399. H IV. 2. Rosse, *Obs. of Neb. and Cl. of Stars*, p. 53. *Phil. Trans.*, 1833, Pl. XIV., Fig. 64, and 1850, Pl. XXXVII., Fig. 10. Lassell, *Mem. R.A.S.*, Vol. XXIII., Pl. II., Fig. 8.

The photograph was taken with the 20-inch reflector on January 27th, 1900, between sidereal time 3h. 43m. and 5h. 13m., with an exposure of the plate during ninety minutes, and it shows the nebula to be in form like a fan, or comet, with a star of about 11th magnitude at the apex. There is faint nebulosity with structural characteristics on the *north preceding* side, and an extension, like a streamer, on the *north following* side. The nebula resembles the two that are near *Gamma Cassiopeia* (pub. in Knowledge, May, 1898; and in *I.R Pho. of Neb. and Cl. of Stars*, Vol. II., Pl. XXV.). It also resembles the nebula H I. 143 *Virginis*. Two or three condensations are visible in the nebulosity. In the *Phil. Trans.*, 1850, Pl. XXXVII., Fig. 10, Lord Rosse has given a drawing of this nebula on which is shown a ring separating the apex from the body, but the photograph does not indicate that appearance.

NEBULA H IV. 28 CORVI.

R.A. 11h. 56m. 46s. Decl. 18° 19′·2 South. Epoch 1900.

Scale—one millimètre to twelve seconds of arc.

References.

N.G.C. 4038-9. G.C. 2670-1. *h* 1052-3. H IV. 28.

In these references the nebula is described as two nebulæ, but Lord Rosse, in the *Phil. Trans.*, part 3, 1861, p. 724, Pl. XXVII., Fig. 18, depicts and describes it as a spiral which in outline corresponds with the photograph hereto annexed.

The photograph was taken with the 20-inch reflector on April 25th, 1900, between sidereal time 11h. 42m. and 13h. 12m., with an exposure of the plate during ninety minutes, and it shows the nebula to be a right-hand spiral with fourteen or fifteen star-like condensations involved in the convolutions, one of which (or probably two or three images overlapping), forms the nucleus, and there is shown on the negative extensions of faint nebulosity in the *north preceding*, south, and *south following* directions. There are some deviations from the symmetrical form on the *north preceding* side, both in the convolution and in the star-like condensations involved in it, and ere long, measurements of the position angles, distances, and fiducial places of reference between the condensations and some of the normal stars surrounding the nebula will be published. Then by aid of the photographs, of diagrams, and of tables of measurements from such fiducial stars, the astronomers of the future will be well equipped for finding out the changes and the progressive development of this and of other spiral nebulæ into star-clusters, or else into systems of stars similar to the innumerable curves and lines of stars which photographs have revealed to us as large constituents of the system of the *Milky Way*. I have now many photographs of spiral nebulæ ready for treatment in the manner here indicated, and have no hesitation in saying that the most promising field for astronomical investigations in the present and in the immediate future will be that in connection with the spiral nebulæ, the result of which will be demonstration of the evolution of stellar systems in this manner from roaming clouds of nebulous or meteoric matter in the expanse of space.

NEBULA MESSIER 61 VIRGINIS.

R.A. 12h. 16m. 48s. Decl. 5° 1′·7 North. Epoch 1900.

Scale—one millimètre to twelve seconds of arc.

References.

N.G.C. 4303. G.C. 2878. *h* 1202. H I. 139. Rosse, *Obs. of Neb. and Cl. St.*, p. 113. *Phil. Trans.*, 1833, Pl. XV., Fig. 69, and 1861, Pl. XXVII., Fig. 21.

The photograph was taken with the 20-inch reflector on May 7th, 1899, between sidereal time 12h. 22m. and 14h. 25m., with an exposure of the plate during two hours and three minutes, and it shows the nebula to be a right-hand spiral viewed in a direction nearly perpendicular with its plane. It has a bright stellar nucleus, and several faint condensations in the convolutions, and two stars in the nebulous spaces between them; there are also two prominent tangential projections of nebulous matter on the *north following* side with a star at each termination, and they suggest the idea of projection by centrifugal force. Similar appearances are also seen on the photographs of the Great Spiral Nebula M. 51 Canum (published in *I.R. Photos. of Neb and Cl. of Stars*, Vol. II., Pl. XV.). There is also shown on the photograph hereto annexed a small faint spiral nebula with a stellar nucleus and three or four condensations in the nebulosity, thirty-two seconds *following* and 5′·9 north of M. 61, which is not recorded in the catalogues, and therefore may not have been observed before.

THE SECOND SERIES OF LINES IN THE SPECTRUM OF HYDROGEN.*

The presence of a second series of hydrogen lines, in addition to the ordinary series, in the spectrum of ζ Puppis, was announced in Circulars Nos. 12, 16, and 18. Accurate wave lengths could not then be determined for the less refrangible lines. Since then, measures have been made of six photographs of spectra of ζ Puppis, and two of spectra of δ Orionis. Following the notation proposed by Vogel for the ordinary series of hydrogen lines, the new series may be designated Hα', Hβ', Hγ', etc. A comparison of the wave lengths recently determined with two computed values, is given in the following table. The first of these is given in Circular No. 16, and is a slight modification of Balmer's formula. It is $3646.1 \frac{n^2}{n^2-16}$, in which n is an even number for the ordinary series of hydrogen lines, and an odd number for the additional series. The second formula is $\frac{1}{\lambda} = A + B\frac{1}{m^2} + C\frac{1}{m^4}$. This form was proposed by Kayser, immediately after the announcement of the

* Abridged from "Harvard College Observatory Circular," No. 55.

discovery of this series of lines. If we accept this formula, it would appear to be the true law connecting their wave lengths, and would render them comparable with those of other elements. The designation of the lines is given in the first column of the followng table, and the wave lengths derived by Mr. King in the second column. The next two columns give the value of n, taken from the sixth column of the table in Circular No. 16, and the computed wave lengths taken from the seventh column of the same table. A similar comparison with the formula $\frac{1}{\lambda} = 27461 - 121790\,\frac{1}{m^2} - 352010\,\frac{1}{m^4}$, is contained in the last two columns of the table.

Des.	Obs.	n.	Comp.	m.	Comp.
$H\alpha'$	...	5	10128.1	3	10435.2
$H\beta'$	5413.6	7	5413.9	4	5413.0
$H\gamma'$	4542.4	9	4543.6	5	4540.1
$H\delta'$	4200.7	11	4201.7	6	4200.6
$H\epsilon'$	4026.0	13	4027.4	7	4027.5
$H\zeta'$	3924.0	15	3925.2	8	3925.8
$H\eta'$	3860.8	17	3859.8	9	3860.6
$H\theta'$	3815.7	19	3815.2	10	3815.4
$H\iota'$	...	21	3783.4	11	3782.1
	...	∞	3646.1	∞	3641.5

On the whole the observed values agree more nearly with the first formula than with the second. This is remarkable, if it does not represent the true law, since this formula contains no arbitrary constants. There is only one constant, and that is determined with great accuracy from the ordinary series of hydrogen lines. The second formula contains three arbitrary constants which are selected so as to represent the observed value as nearly as possible. A least square determination was not considered necessary, since the outstanding differences from observation were evidently systematic, and not accidental. The wave length of the line $H\alpha'$ differs greatly according to the two formulas, but no means as yet exist for determining radiations of such great wave length in the stars.

Cambridge, U.S., EDWARD C. PICKERING.
February 11th, 1901.

[The interest attached to the "second series" of hydrogen lines arises from the fact that they were identified as probably belonging to hydrogen by a purely mathematical process.

It is a remarkable circumstance that we are so much indebted to a study of the celestial bodies for our knowledge of the spectrum of hydrogen. Even the ordinary series of lines in this spectrum was first recognised in its entirety in the photographic spectra of white stars, but unlike these, the new series has not yet been reproduced in terrestrial experiments. Carrying Prof. Pickering's inquiry a step further, Rydberg has concluded that there is still another series of hydrogen lines, of which the only one in the visible spectrum is about wave-length 4687.8; this also has not yet been artificially reproduced, but there is evidence that it is represented by an important line in the spectra of some of the Wolf-Rayet stars and planetary nebulæ.

The three series of lines of hydrogen thus differ from the corresponding series in the case of many other elements, inasmuch as they do not all appear simultaneously in the spectrum of the gas in laboratory experiments.—ED.]

Letter.

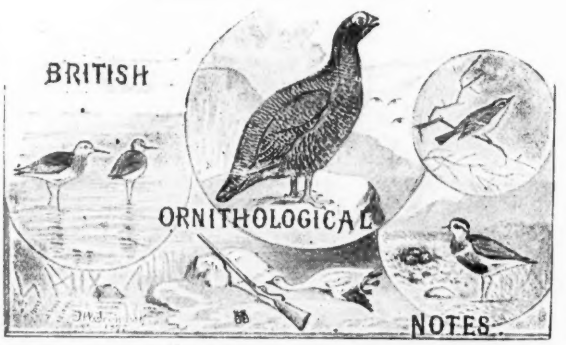
[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

LUNAR ATMOSPHERE AND OCEANS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—It has been considered (Proctor's "The Moon," pp. 263-265) that the theory that the hypothetical oceans and atmosphere formerly possessed by the moon have been withdrawn to internal cavities is untenable—though the existence of such cavities seems probable enough—since they could not be large enough to contain the volume of an atmosphere sufficient in quantity ever to possess any considerable density on the moon's surface. Also, it seems very improbable that the surface is at a sufficiently low temperature during the day to allow the atmosphere to remain always in a liquid or solid state on the surface. Now might we not combine these two theories with advantage? If all the moon's heat has been lost, any cavities in its structure must be at a temperature sufficiently low to reduce all gases entering them to the solid state; and these cavities, a few miles from the surface, will not be appreciably affected by solar heat. The cavities, which must be supposed to be in connection with the surface to some extent, would be full of air. When their temperature became sufficiently low, this air would liquefy, leaving an almost empty space. Into this space there would be a constant slight influx of gas throughout the day, the liquefaction, or, later, solidification of which would leave room for further quantities of air. If the temperature of the moon's mass has become equal to that of surrounding space throughout, may we not suppose that the whole, or very nearly the whole, of the atmosphere, as well as the oceans, may not be within the moon's mass, *in the solid state*, assuming, of course, that they have had an existence at all? The small quantities of heat introduced would be lost by conduction through the surrounding material, and could never, of course, stop the process.

J. O'MAY.



Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

RED-FACED VARIETY OF THE YELLOW HAMMER.—At the meeting of the British Ornithological Club, held on June 19th, Mr. H. E. Dresser exhibited an aberrant form of *Emberiza citrinella*, with chestnut-red colour on the throat like the Pine Bunting (*Emberiza leucocephala*). The specimen was obtained by Mr. E. S. Montagu in Cambridgeshire. Mr. Millais and Mr. Walter Rothschild also exhibited British examples of this aberrant form. In

the course of some remarks in the *Ibis* (July, 1901, p. 453), upon a similar specimen obtained at Yeniseisk, Mr. H. L. Popham writes that Mr. Zarudny "considers that this variety points, to some extent, to atavism, and suggests an early ancestral form of *E. citrinella*, nearly related to *E. leucocephala*."—H. F. W.

ATTEMPT TO RE-INTRODUCE THE GREAT BUSTARD IN NORFOLK.—Your readers are aware* of the attempt recently made to re-introduce the Bustard into its old haunts on the borders of the counties of Norfolk and Suffolk, and that a number of these birds were sent from Spain to the care of Lord Walsingham, to whom the management of the interesting experiment was entrusted. Fifteen of these birds have survived the winter at Elveden, where they were placed on the estate of Lord Iveagh and allowed a run of some 800 acres of the same country which the indigenous race formerly frequented. All seemed going on well, but, unfortunately, the birds, which had become very tame, left their secure retreat and seem to have spread over the country—the result was, as it was too much to be feared, that two of them have been killed, and that by a gamekeeper at Finningham, who of all persons, the experiment having been largely advertised, should have aided in protecting them. Of course the naturalists of Norfolk were greatly disgusted at this unpardonable act, and immediately drew the attention of the Society for the Protection of Birds to the infraction of the Game Laws, and I understand that the man is to be proceeded against at the next meeting of the magistrates at Eye, Suffolk, for shooting game out of season. The punishment of the man, if convicted, will certainly be altogether inadequate, but the publicity thus gained may prevent others from repeating the offence, and to some extent protect the remaining thirteen birds which are at large should they not also have been killed, and their destroyers, warned by this example, have concealed the fact, which is too much to be feared.—T. SOUTHWELL, Norwich.

[It is reported that Arthur Larkings, gamekeeper, Westhorpe, was convicted of the above offence at the Hartismere Petty Sessions, on July 8th, and fined the full penalty of one pound per bird, with £2 15s. costs, or in default one month's hard labour. W. H. Read, keeper to Lord Iveagh, remarked that of seventeen Great Bustards imported only seven remained. As Mr. Southwell predicted, the penalty for Larkings' abominable deed is wholly inadequate, especially as the birds themselves cannot be confiscated. The law as it at present stands is altogether too weak to prevent these murderous acts. Is there no ornithologist in Norfolk of sufficient strength and courage to take the law into his own hands and administer a punishment to fit the crime?—H. F. W.]

Breeding of Wigeon in Ireland (*Irish Naturalist*, July, 1901, p. 147).—Mr. Robert Patterson has the satisfaction of being the first to record the breeding of the Wigeon in Ireland. The bird has been suspected of breeding there, but the eggs have never before been found. Some ducks' eggs which Mr. Patterson could not identify were sent to him by Mr. John Cottney, who found them near Belfast, in May last. Mr. Patterson accordingly visited the place on May 18, and found a nest with similar eggs, from which he flushed a Wigeon. Mr Ussher has compared the eggs and down, and "has no doubt whatever that they are Wigeon's."

White Wagtail at Bartragh, co. Mayo (*Irish Naturalist*, July, 1901, p. 146)—Mr. Robert Warren records that Mr. Kirkwood has again this year observed White Wagtails at Bartragh. Since this Wagtail has been seen during April and May, in the years 1898, 1899, 1900, and 1901, on Bartragh Island, it may be assumed that the west coast of Ireland forms one of its regular migratory routes to the north.

Migration of Birds in N.E. Lincolnshire during the Autumn of 1900. By G. H. Caton Haigh. (*Zoologist*, June, 1901, pp. 201–211).—Mr. Haigh's annual contribution to our contemporary is of great value to students of migration. Mr. Haigh remarks that "the chief feature of the last autumn passage was the almost complete total absence of visible migration. . . . No rare birds were met with in the district, but among the scarce visitors may be mentioned the Bittern, Red-necked Phalarope, Wood-sandpiper, and Little Auk." A number of birds of regular occurrence were conspicuous by their absence last autumn.

On the Winter Singing of the Song-Thrush (Turdus musicus). By W. Warde Fowler, M.A. (*Zoologist*, June, 1901, pp 212–218).—In a pleasantly written article founded upon personal observation, Mr. Fowler comes to the conclusion that the Song-Thrush sings in winter in still open weather when food is easy to get at. He is inclined to think that in the case of mature birds the winter song is a forecast of the coming breeding season, while the immature may very possibly use their voices only in what has been termed "voice-play."

Rose-coloured Pastor in Kent (*Zoologist*, June, 1901, p. 223).—Mr. L. A. Curtis Edwards records that an adult male of this irregular visitor to Great Britain was secured on May 14 in Romney Marsh.

Red-footed Falcon in Shropshire (*Zoologist*, June, 1901, p. 224).—Mr. H. E. Forrest writes that an immature female specimen of this Falcon, which is a summer visitor to Europe, and rarely reaches as far north-west as Great Britain, was shot near Shrewsbury on May 18.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, ***at 10, St. Germans' Place, Blackheath, Kent.***

Notices of Books.

"MORPHOLOGY OF SPERMATOPHYTES." By J. M. Coulter, PH.D., and C. J. Chamberlain, PH.D. (New York: D. Appleton & Co.—This book presents in a practical and informing manner comprehensive information gleaned from numerous authorities together with original investigations and observations of the authors on the morphology of seed plants. The various chapters are devoted to the treatment of Cycadales, Ginkgoales, Coniferales, Gnetales and the Fossil Morphology, Phylogeny, and geographic distribution of gymnosperms. The provision of laboratories in regions where the plants are indigenous has enabled their peculiar characteristics to be studied in a thorough manner, and an increasing amount of attention has been and is being devoted to the subject. Numerous illustrations render the text clear, and the histological structure as revealed by the microscope is well displayed. The progressive nature of the investigations and the extent of the ground that is covered by the groups dealt with, precludes finality of knowledge and information, but the present work, which brings many new and interesting facts to light, has been prepared with great care and discrimination, and is written in a very lucid and interesting manner.

"THE NORWEGIAN NORTH POLAR EXPEDITION, 1893-1896. Scientific Results." Vol. II. Edited by Fridtjof Nansen. (Longmans, Green & Co.) 30s. net.—This second volume of scientific results shows even more clearly than the first that the Norwegian North Polar Expedition was not merely an attempt to reach the North Pole, but a well organized scientific expedition, prepared under the direction of a capable leader who was fully aware of the opportunities afforded by such an expedition.

The volume is divided into three Memoirs—VI., VII., and VIII.—dealing with the astronomical, magnetic, and pendulum observations, nearly all of which, with the exception of the observations from the sledge journey, were made by Captain Sigurd Scott-Hansen. These observations have been brought together and discussed with that thoroughness and detail that marks the whole expedition, ranking it easily first among recent expeditions of this nature.

Memoir VI., containing the astronomical observations, has been prepared by Prof. H. Geelmuyden, whilst Prof. H .H. Turner has also gone over the proofs of the introduction to this section. The astronomical equipment consisted of alt-azimuths, sextants, telescopes, together with chronometers and azimuth compasses. For the determination of latitude and local time a large alt-azimuth of 2-inch aperture was most frequently used, and the method by altitudes adopted. As will be readily seen, this method in high latitudes is subject to somewhat large errors, but remembering that the ship was not stationary, but

* *See* KNOWLEDGE, October, 1900, p. 230.

drifting irregularly with the ice, the elements of uncertainty are of the same magnitude throughout, a small drift giving a considerable difference in longitude and local time. For the rating of the chronometers for use with the half seconds pendulums, observations made by the above method were useless, and consequently observations of the solar eclipses of 1894, April 5, and 1895, March 25, as well as observations of lunar distances and eclipses of Jupiter's Satellites were employed for the determination of Greenwich time. During the famous sledge journey of Nansen and Johansen it happened once that the working day of the men had been longer than that of the watches, with the result that both watches ran down, and henceforth the determination of longitude on this journey became more difficult, for in addition to this the tables of lunar distances had (probably on account of portability) been cut out of the "Nautical Almanac," and although Nansen was continually on the look out for the moon during her period of visibility he was only able to make one observation, in consequence of the difficulty of picking up the moon by the naked eye on the pale sky, with the strong reflection from the immense white surface of ice. All the observations involving altitude were corrected by a refraction table with an extension of the temperature table down to $-50°$ C., calculated by Bessel's formula, and observations were made on the sun and certain stars at temperatures ranging from $-14·4°$ C. to $-50·0°$ C., so that some idea of the accuracy of the prepared table can be made.

Memoir VII. contains the magnetic observations made by Capt. Scott-Hansen during the voyage of the "Fram," as well as the few results it was possible to obtain on the sledge journey; it has been prepared by Prof. Aksel S. Steen of Christiana, and Prof. Ad. Schmidt of Gotha has increased the scientific interest of these results by calculating the theoretical values of the magnetic elements for all localities where magnetic observations were made. Dr. Schmidt's computed values are, however, for the epoch 1885, whilst the observations were made during the period 1893-1896. These observed results are tabulated, and the O—C's for declination, horizontal force, and inclination given in adjoining columns. The differences are in some cases large, e.g., the declination varies from $-5°$ to $+10°$, but bearing in mind that they are for different epochs, and that they are uncorrected for diurnal variation, the observations show as close an agreement with theory as might reasonably be expected. Observations were made at 225 different places on 194 days, giving 70 declination, 99 horizontal intensity, and 80 dip results. The instrument by which the observations were made was specially designed by Dr. Neumayer for the conditions to be encountered, and was a combination of the Neumayer Declinatorium and the Fox Circle. As in all high latitudes magnetic storms were somewhat frequent, and during 1½ hours on 24 November, 1894, the declination needle was perturbed through 26°. Captain Scott-Hansen does not, however, seem to have made any systematic observations for diurnal variation, but when it is remembered that the observations were frequently made with instruments mounted on an ice pillar and out in the open, ever liable to an attack from bears, the results are highly creditable. One reads that as a defence against bears a weapon, generally a revolver, was always at hand, though of course at a sufficient distance not to influence the readings.

Memoir VIII. deals with the pendulum observations, and has been prepared by Prof. O. E. Schitz. The pendulums were of Col. von Sterneck's type, such as has been used by him on the Austrian Military Survey, i.e., half-seconds pendulum of invariable length. In a journey such as the "Fram's," opportunity did not exist for setting them up on the solid earth, and they were accordingly swung on the ship when drifting in the ice, and also on the ice itself. Such a proceeding would be highly satisfactory as being free from local influence due to mountains on high land, if it could be satisfactorily proved that the ice was rigid enough. The observations, however, are the first that have ever been taken at sea as it might be called, and show that there is nothing abnormal about the force of gravity over the polar basin, the result being $g = 983·147$ for mean latitude 85°, and, therefore, Prof. Schitz assumes that it is normal over all the great oceans. All the swings appear to have been made at the normal pressure; it would, perhaps, have been more interesting if they had been made at the usual pressure of 50 mm., and swung over 24 hours, but the chronometers could not be rated to the ideal accuracy, and the ice changes would, no doubt, have been greater. Capt. Scott-Hansen is to be commended on doing the right thing under the circumstances, and thus securing valuable results. The amount of work to show by so small a band as that on board the "Fram" fills one with admiration, and at least one could not have found time to suffer from ennui—Capt. Sigurd Scott-Hansen—whom Nansen deservedly praises for the excellent work done by him under difficult conditions, and brought together in the three Memoirs cited above.

"THE BIRDS OF SIBERIA." By Henry Seebohm, F.L.S., F.Z.S., F.R.G.S. (Murray.) Illustrated. 12s. net.—The late Mr. Seebohm's two delightful books "Siberia in Europe" and "Siberia in Asia," have long been so rare and difficult to obtain that this volume which is practically a reprint of these books of travel will be very welcome to those who are not the fortunate possessors of the original volumes. The first journey to the River Petchora was, we believe, planned and originated by Mr. J. A. Harvie-Brown, who was Mr. Seebohm's companion on the expedition. In the Petchora delta the grey plover, the little stint and Bewick's swan were found breeding, and well authenticated eggs were brought home. The eggs of Bewick's swan had never before been discovered, while those of the grey plover and little stint were almost unknown. In the second journey, accompanied by Captain Wiggins, Mr. Seebohm explored the great river Yenesei, from Krasnoyarsk to its mouth. The eggs of many little known birds were obtained, and a large and interesting collection of birds was made. At the time of the author's journeys (1875 and 1877) there was no railway east of Moscow, and enormous journeys by sledge in winter had to be undertaken. The book by no means deals exclusively with birds. The sledge and boat travelling are vividly described; there are many interesting observations on the natives of Siberia, and the breaking up of the ice on the great rivers is graphically depicted. The present volume has been only slightly edited, and several inaccuracies and repetitions have been allowed to remain. A few notes, comprising chiefly Mr. Popham's ornithological discoveries on the Yenesei, have been added to the text. We do not admire the cover, but the inside of the book is well printed, and two fascinating books of travel are now brought within easy reach of those interested in northern regions.

"THE ELEMENTS OF DARWINISM." By A. J. Ogilvy. (Jarrold & Sons.) 2s. 6d.—It is impossible for anyone who is not a naturalist by instinct and observation to appreciate to the fullest extent the structure upon which evolution depends for support, whether it be natural selection or acquired characteristics. A broad and general knowledge of the conditions and processes involved can be obtained by reading, and there are many people who are satisfied with such a view. Mr. Ogilvy gives a survey of Darwinism suitable for readers of this class. His book is a primer which can be understood by those who are unfamiliar with the technicalities of natural history, even though sometimes they may not see the real significance of the facts described. Every cultivated person ought to have grasped the simple statements and principles expounded in this little volume, because the knowledge would make them realise their responsibilities in the natural and social worlds. Of course, as the book only surveys Darwinism it is not a complete statement of the doctrine of evolution, and it may lead to the idea that the two terms are synonymous. But sufficient is said to show the reader that natural selection is not the only road to evolution, and interested students will follow up the subject in other books. Dr. Wallace looked through Mr. Ogilvy's book before publication, and the contents have his general approval, though the author alone is responsible for the treatment of the subject.

"ELEMENTARY PRACTICAL MATHEMATICS." By M. T. Ormsby. (E. & F. Spon.) 7s. 6d. net.—A great change is taking place in the methods of teaching mathematics. The old idea that only those parts of the subject of which a student knows the rigid proof should be used by him is becoming discredited. The opinion is gaining ground that it is advantageous to teach students, especially practical men engaged in engineering and the constructive arts, the application of mathematical results, leaving the formal steps by which such formulæ are arrived at to the professional mathematician. Just as in ordinary life it is not considered necessary for every person who carries a watch to understand its mechanism before telling the time of day, it is very reasonably argued that an engineer should know how, for example, to simplify his calculations by the use of logarithms, even though he may be ignorant of the proof of the Binomial Theorem. This view of the teaching of mathematics has recently received official sanction by the publication, in the "Directory" of the Board of Education, of a Practical Mathematics Syllabus. It is to meet the requirements of students such as those who present themselves for the South Kensington examination that Mr. Ormsby has written his book. He has included in it all those parts of arithmetic, algebra, trigonometry, geometry, and the calculus, which are frequently employed in the workshop, and while using great care to prevent the formation of misconceptions on the part of the reader, he has kept steadily in view those problems and theorems of constant use in everyday practice. Graphic work, especially the plotting of curves,

takes very properly a prominent part in the course of work. We are afraid, however, that the book includes too much for the great majority of technical students, and its price is more than many can afford. But the book will serve as an excellent work of reference in the drawing-office and workshop.

"DESCHANEL'S NATURAL PHILOSOPHY." Part III. Electricity. Prof. J. D. Everett, M.A., D.C.L., F.R.S. (Blackie & Son.) 1901. —Deschanel's work has been a standard students' book for many years through the translation made by Prof. Everett. In this part, which is devoted to Electricity and Magnetism, the amount of progress to be reported has become so great as to necessitate almost a complete rewriting. Many of the old figures still remain, but the text is very much changed. Attention can be directed to a few of the novelties only. The modern ideas of electrical action are fully stated: accounts of practical terms are given, such as "angle of lead," "characteristic curves," and the like. The usual method of conveying electric power by polyphase currents: Ewing's magnetic tests of iron: descriptions of modern galvanometers: Hertz's experiments: Poynting's theorem on the propagation of electro-magnetic energy—these references will sufficiently demonstrate that the book is up-to-date. Deschanel's treatise always occupied a special rank of its own. It was not simply a record of discovery more or less furnished with links of "theory": in short it was scientific in spirit. We think in the present edition, Prof. Everett is to be congratulated on having maintained this position. The rigour of the work has not diminished—has not been sacrificed to give a smattering of the things which are newest. It is a book for study. Used by students who are receiving at the same time a good practical laboratory course, it will be of great value in keeping the fact before them that a knowledge of electricity does not solely consist in being able to carry out certain measurements. The amount of work necessary to master the contents of the book is much more than its size would probably indicate. Occasionally the style seems difficult, but to the earnest student this will be an incentive to close study.

BOOKS RECEIVED.

Colloquies of Criticism. (Fisher Unwin.) 3s. 6d. net.

Two Undiscovered Planets. By G. E. Sutcliffe. (Bombay: Theosophical Book Depôt.)

Poems. By W. B. Yeats. (Fisher Unwin.) 7s. 6d.

Matriculation Directory (The University Tutorial Series). June, 1901. (Cambridge: Burlington House.) 1s. net.

Sculptures of Santa Lucia Cozumahualpa, Guatemala, in the Ethnological Museum of Berlin. By Herman Strebel. (Smithsonian Institution.)

Poisonous Plants in Field and Garden. By the Rev. Prof. G. Henslow, M.A., F.L.S., F.G.S., &c. (Society for Promoting Christian Knowledge.) Illustrated. 2s. 6d.

Fifty Years of Catholic Life and Social Progress. Vols. I. and II. By Percy Fitzgerald, M.A., F.S.A. (Fisher Unwin.) 21s.

Microscope and its Revelations. By the late William B. Carpenter, C.B., M.B., LL.D., F.R.S. Revised by the Rev. W. H. Dallinger, D.SC., D.C.L., LL.D., F.R.S., &c. (J. & A. Churchill.) Illustrated. 28s.

Life and Letters of Gilbert White. 2 Vols. By Rashleigh Holt-White. (Murray.) 32s.

Natural History and Antiquities of Selborne. By Gilbert White. Edited by L. C. Miall and W. Warde Fowler. (Methuen & Co.) 6s.

Retrospect of Surgery during the Past Century. By John Poland, F.R.C.S. (Smith Elder.) 5s.

Hypnotism and Suggestion in Therapeutics, Education and Reform. By R. Osgood Mason, A.M., M.D. (Kegan Paul.) 6s.

Journal of the Society of Comparative Legislation. June, 1901. (Murray.) 5s.

Civilian War Hospital. By the Professional Staff, Portland Hospital. (Murray.) 12s. net.

Your Mesmeric Forces and How to Develop them. By Frank H. Randall. (Fowler.) 2s. 6d. net.

International Art Notes. March, 1901. (Swan Sonnenschein.) 6d. net.

Stalk-eyed Crustacea of British Guiana, West Indies, and Bermuda. By Charles G. Young, M.A., M.D. (Watkins.) 12s. 6d. net.

Amphibia and Reptiles. By Hans Gadow, M.A., F.R.S., &c. (Macmillan.) Illustrated. 17s. net.

Bulletins of the Philosophical Society of Washington.

Annual Reports of the Bureau of American Ethnology. Seventeenth (Part I.—1895-96). Eighteenth (Part I.—1896-97).

Catalogue of Photo Apparatus. City Sale and Exchange, 93 and 94, Fleet Street.

NOTES.

ASTRONOMICAL.—We note with regret that the two photographs of Nova Persei and surrounding stars, reproduced in the July number, were dated 1900, February 20, and 1900, February 28. In each case the year should, of course, have been 1901.

In Circular No. 50, Prof. Pickering gives a summary of the observations of Nova Persei made at Harvard up to May 3, 1901. The characteristics of the spectrum prior to March 19 are sufficiently well known to need no further reference here, and the subsequent observations may be regarded as confirmatory of those made at Stonyhurst, Kensington, and elsewhere. About March 19, the star became a variable with a period of from 2 to 5 days, and the general result of the Harvard photographs seems to be that there were well-marked variations of spectrum accompanying the changes of magnitude. On March 27, 30, April 1, 13, and 27, the spectrum was "normal," while on March 19, April 12, 26, 28, May 1, and 3, it was "peculiar"; among the chief peculiarities apparently being that a green band extending from 4990 to 5040 was greatly intensified, while H ζ was either displaced or replaced by a new line with its centre about λ 3875. The "peculiar" spectrum was associated with a minimum of the star except on April 12. No attempt is made to explain the origin of the peculiar lines, but it is not improbable that the green band, which was brighter at the minima, was the chief nebular line at λ 5007, while the band with its centre about λ 3875 was possibly identical with a line which is among the brightest in the spectrum of the Orion nebula and certain planetary nebulæ.

A recent investigation of sun-spot data undertaken by Dr. W. J. Lockyer has led to the conclusion that underlying the recognised 11-yearly period there is another cycle of about 35 years' duration. This periodicity exhibits itself in the varying intervals between the minima and succeeding maxima, and in the total spotted area from one 11-yearly period to another. Corresponding variations have also been traced in the curves of the terrestrial magnetic elements. A 35-yearly period has been previously found by Brückner in climatic changes, and by Richter in the movements of glaciers, while Mr. Egerson has found a period of from 33 to 34 years in the occurrence of rainfall, thunderstorms, and westerly winds in the month of April at Sydney.

We learn from Mr. Maunder that he has been detained at Mauritius, and will not reach England until late in August. On his return, Mr. Maunder will publish in this journal a plate of the Sun's corona, of which successful photographs have been obtained.—A. F.

BOTANICAL.—A paper on the longevity of seeds, based on the examination of numerous grains of wheat and barley discovered during recent investigations in Egypt, and dating back upwards of four thousand years, appeared in Vol. 130 of the *Comptes Rendus de l'Académie des Sciences, Paris.* The conclusions of the author, Monsieur Gain, are distinctly opposed to those

of Alphonse de Candolle, who did not consider it impossible that a seed may preserve its vitality for four or five thousand years; and the testimony of Count Sternberg, who believed that he had actually procured the germination of two grains of mummy wheat, is dismissed as valueless. It is shown that in order for an old seed to germinate three conditions are necessary: First, the reserve material must remain chemically intact, and this is the case in many grains of mummy wheat and barley; second, the embryo must retain an organisation so that the enzyme required for the digestion of the reserve material may be produced; and third, if the preceding condition is realised, it would also be necessary that the embryo should remain in contact with the reserve material. In the seeds examined the embryo no longer existed in contact with the albumen, and though it retained its cellular organisation, each cell had undergone a chemical change indicating the death of the embryo at a remote period. The author concludes that grains of mummy wheat and barley, in spite of their external appearance of good preservation, do not possess a cellular organisation compatible with germination.—S. A. S.

Entomological.—Some interesting researches under the direction of Dr. A. Weismann, and published by him in the *Anatom. Anzeiger* (Vol. XVIII., 1900, pp. 492-9), confirm the well-known view that the unfertilized eggs of the Honey-bee develop into drones, while the fertilized eggs always give rise to queens or workers. Considerable doubt has lately been thrown on this doctrine by practical bee-keepers, but the question seems altogether set at rest by Weismann's examination of over 300 eggs in the stage (that of the "second maturation spindle") when the sperm-aster, if present, can always be detected. In every one of the 62 eggs from worker-cells examined a sperm-aster was found; while only one of the 272 eggs from drone-cells contained a sperm-aster, and this was almost certainly due to a mistake on the part of the queen-bee, who is able to lay either fertilized or unfertilized eggs at will.

The development of the eggs and other cells in the ovary of the Queen-bee forms the subject of an exhaustive paper by W. Paulcke in the *Zoolog. Jahrb.* (*abth. f. anat.*), XIV., 1900, pp. 178-202, pls. 12, 12a, 13, 13a. In the thread-like ends of the ovarian tubes are numerous undifferentiated nuclei embedded in a common protoplasm. Further down the tubes some of these are seen to give rise to the cells of the follicular epithelium, while others form the eggs and the yolk-cells. The eggs and yolk-cells are formed by repeated division of the primitive germ-cells—forty-eight yolk-cells being produced for each egg, and the cluster of yolk-cells becomes separated from its neighbouring egg-cell by a follicular layer. The yolk-cells at first show marked growth and produce food-material which the egg absorbs by protruding a process into the yolk-follicle. Ultimately, before the eggs enter the oviduct, the yolk-cells pass into the egg-follicle and become entirely engulfed by the egg-protoplasm.—G. H. C.

Zoological.—By far the most important event we have to record in this column, so far as vertebrate zoology is concerned, is Professor E. Ray Lankester's exhibition before the Zoological Society of the skin and skull of the new mammal lately discovered by Sir Harry Johnston in the eastern borders of the Congo forest. The professor fully confirmed Sir Harry's opinion as to the intimate affinity existing between the okapi (as the new animal is called by the natives) and the extinct *Helladotherium* of the Tertiary deposits of Greece. It is believed, however, to be generically distinct, and the name *Okapia johnstoni* was accordingly suggested as its designation, the specific title having been previously proposed by Mr. Sclater, on the evidence of two pieces of skin sent home at an earlier date by Sir H. Johnston. The animal appears to be a comparatively short-necked, and short-legged representative of the giraffes; the general colour of the upper-parts being purplish-brown, with the thighs and upper part of the legs transversely striped in a somewhat zebra-like fashion. The skin, which has been mounted by Rowland Ward, Ltd., will probably be on exhibition at the Natural History Museum by the time these lines appear. For fuller details regarding this most interesting creature, we must await Prof. Lankester's promised memoir; but it may be observed that no such important discovery has taken place within the memory of the present generation. It is noteworthy that the Grecian deposits which yield *Helladotherium* also contain remains of giraffes.

In an article published in the June number of the *Geological Magazine*, Dr. C. J. Forsyth Major discusses the acquisition by the female of secondary sexual characters originally distinctive of the male. He shows, for example, that the females of the oxen were originally hornless; and that in those antelopes in which horns are present in both sexes they were originally restricted to the males, as is still the case in many genera of these ruminants. Of especial interest are the author's observations relating to the antlers of the deer, which, as is well known are, with the exception of the reindeer, normally restricted to the stags alone. It is pointed out that in one district of Russia reindeer hinds are reported to be still devoid of antlers; and evidence is adduced showing that in the roedeer the female is now tending to acquire antlers, those appendages being frequently developed in that sex at all ages.

Visitors to the palæontological galleries of the Natural History Museum cannot fail to be struck with the skeleton of a huge, half frog-like, half salamander-like extinct reptile from South Africa, labelled *Pariasaurus*. Hitherto these strange creatures have been regarded as exclusively African, but news now comes of their discovery in Russia. This is a fact of the highest importance to the students of the geographical distribution of animals.

We wish every success to the Fifth International Congress of Zoology, which is to be held in Berlin from the 12th to the 16th of August. A good programme has been arranged, and a large number of papers for reading have been promised. On August 17th Hamburg and its excellent Zoological Gardens and Museum will be visited by those who care, while on August 18 there will be an excursion to Heligoland.

Polar Exploration.—The present year promises to be a record one in the way of Antarctic and Arctic Expeditions, as whilst four sail to explore the former regions, no less than ten will be at work in the opposite parts of the globe, viz.: (1) The Ziegler-Baldwin Expedition from America, attempting to reach the Pole; (2) the Russian Expedition, under Admiral Makaroff, on the famous ice-breaker "Ermak," built in England, exploring the regions between Spitzbergen and Novoya Semlja; (3) a Canadian Expedition under Capt. Bernier, of Quebec, sailing north from St. Johns with the object

of reaching the Pole *viâ* Smith Sound; (4) a German Expedition from Hamburg with the same object by another route; (5) the "Capella" Expedition to Franz Joseph Land in search of the missing men of the Duke of the Abruzzi's Expedition; (6) the Peary Expedition in North Greenland; (7) the "Fram" Expedition under Capt. Johannesen, of Nansen Expedition fame, in the same regions; (8) Dr. Stein's Expedition in Ellesmere Land, returning this year; (9) Baron Toll's Expedition, which sailed last year in order to attempt to reach the Pole by Nansen's route, *viâ* the New Siberian Islands and the mysterious "Wrangel Land," and, finally (10) the Swedish Expedition to Spitzbergen. The object of this last expedition is to measure the arc of the meridian, a work commenced there last year in conjunction with a Russian station in another part, the location of which will depend on the state of the ice. The expedition left Tromsö, in Norway, early in June, on board the well-known whaler "Antarctic," and returns in the autumn, when this vessel will carry the Nordenskjöld Expedition to the South Polar Continent, and will thus in the same year have sailed both the Arctic and the Antarctic seas.

MEN AND MICROBES

By E. STENHOUSE, A.R.C.S., B.SC.

THE end of one century and the beginning of a new one seems an appropriate time for a stock-taking of progress—a time when we may usefully pause to estimate, to the best of our ability, the position in nature to which "civilisation" has brought us.

In such a mental survey at the present time nothing is more striking than our recognition of the fact that our daily lives are intimately bound up, for weal or woe, with the activities of countless hordes of tiny beings whose very existence was undreamt of a hundred years ago.

Bacteria or microbes are as ubiquitous as anything well can be. They occur in the water we drink, in the air we breathe, in the soil beneath our feet, and even in the interior of our own bodies. Were it not for the many services they continually perform for us, our life would be quite impossible; and, on the other hand, they have been proved to be responsible for the greater number of the infective diseases to which we are subject.

So minute are the possessors of these boundless powers for good and evil, that it is often necessary to magnify them some 800,000 times before they can be seen at all distinctly. To give some idea of this enormous magnification, it may be mentioned that an ordinary cigarette magnified in the same proportion would appear seventy yards long and about twenty-eight feet thick.

A bacterium of the cigarette-shape is known as a *bacillus*. The place of the tobacco of the cigarette is taken by a jelly-like substance called protoplasm; and the cigarette-paper is represented by an envelope which, however, covers in the protoplasm completely—at the ends as well as at the sides of the bacillus. Many bacilli possess threadlike outgrowths, by the lashing of which they are propelled through any liquid in which they may find themselves. Other forms, called *spirilla*, move by a serpentine twisting of their slender bodies; and yet other bacteria are globular in shape and are known as *cocci*. When a bacterium is full grown, it multiplies by breaking up into two or more pieces, each of which becomes a complete bacterium. As a bacillus becomes adult in half an hour, or less, one individual can thus give rise to about 17,000,000 in twenty-four hours. When the supply of food runs short, or the surroundings become in other respects unfavourable, many bacteria form themselves into spores, which possess very great powers of resistance. They remain in the resting stage until the hard times are over, and then, with unimpaired vigour, resume their ordinary mode of life.

Of the many useful services which bacteria perform, perhaps the most conspicuous is that of breaking up refuse animal and vegetable matter into harmless and often useful substances. That the putrefaction of organic matter is really due to minute and air-borne forms of life was proved conclusively by Pasteur and Tyndall about the middle of the nineteenth century. It was shown that if well-boiled broth is kept in vessels from which the air is either wholly excluded or so admitted that all floating particles are arrested, no putrefaction occurs, and the broth remains sweet for an indefinite time.

The importance of bacteriological research is persistently forcing itself upon the attention of municipal authorities, not only because it shows how disease-epidemics may be best prevented and stamped out, but also because it indicates solutions of such important problems of public health as the disposal of sewage. Various modifications of the biological treatment of sewage are already at work in this country, and are giving very encouraging results. Essentially, the process consists in passing the sewage—which may previously have been partially purified by allowing the grosser particles to settle in tanks—through filter-beds of clinker or broken coke. A scum soon forms on the coke, and microscopic examination shows that the scum swarms with myriads of bacteria. The bacteria break up the foul organic matter into harmless substances. The efficacy of their work may be judged by the fact that of several effluents I have recently analysed, the putrescent organic matter had on the average been reduced to less than one-seventh as the liquid was trickling through the coke.

It has been found that bacteria play a most important part in enriching the soil with nitrates, a very necessary food of plants. Generally the raw material consists of the simpler compounds of nitrogen—those of ammonia, for example; but the roots of leguminous plants contain bacteria with the very remarkable power of taking nitrogen directly from the air and putting it at the disposal of the plant.

The propriety of including yeast-cells with bacteria is, perhaps, questionable; but the indirect influence upon frail humanity of these minute manufacturers of alcohol is so great that they can scarcely be ignored here. It is becoming widely recognised that several species of yeasts exist, and that success in brewing depends largely upon the rigorous exclusion of the "wild" varieties.

The careful work of the brewer may be brought to naught in a few hours by the activities of another microbe, should it gain access to the finished beverage. The vinegar-organism, as it is called, attacks the alcohol and changes it into acetic acid. Neither beer nor wine ever "goes sour" of itself, if this little plant is absent. Similarly, milk is turned sour by the lactic acid bacillus. Still others give their characteristic flavours to butter and cheese; and it has even been asserted that many of the changes which tobacco undergoes in curing and mellowing are due to the action of bacteria. Certain workers are at present investigating this important

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point, with the object of breeding pure cultures of the races to which a good cigar may owe its peculiarly seductive aroma.

These are a few only of the almost numberless cases in which we are indebted not only for our luxuries but for the very means of life itself, to the silent but ceaseless labours of these tiny organisms. Moreover, if there is anything whatever in the theory of modification by descent, we ought to be able—considering their fabulous rate of multiplication—to bring about in a comparatively short time changes in the structure and habits of some of our "tame" bacteria which will make them minister to our health and comfort to a degree hitherto undreamt of.

Whilst, however, we freely admit our great indebtedness to bacteria, we must not forget that their powers for evil are also enormous.

In 1849, Pollender discovered minute rod-like bodies, one four-thousandth of an inch long, in the blood of animals which had died of anthrax or splenic fever, and he suggested that these tiny rods bore some definite relation to the disease. Fourteen years later Davaine announced that the rods were living plants, and that blood containing them had the power of passing on the disease to another animal inoculated with it; while blood from which the bacilli were absent had no power of conferring the disease. About 1876 Koch discovered how to grow the organism outside the body; and Pasteur subsequently found that by keeping artificial cultures of the anthrax bacillus at a temperature slightly above that of the blood the organisms gradually lost their deadly power, and after 43 days had no injurious effects upon even the most susceptible animals. After being inoculated with such harmless cultures, the animals were subjected to the action of cultures of gradually increasing strength, until after a short time it was found that they could easily withstand a dose which would at first have proved immediately fatal. The animals had, in fact, become protected against the disease. This brilliant discovery has already been put to very extensive use, and the method of inoculation is now recognised as a certain means of protecting horses, sheep, cattle, and even elephants against the ravages of splenic fever.

The activities of the anthrax bacillus may be regarded as illustrating the ways of malignant bacteria generally. There is, however, considerable variation in minor details of structure and mode of life. For example, while the rod-shape or bacillus is the form of the organisms responsible for anthrax, typhoid, diphtheria, "consumption," and some other diseases, the microbes giving rise to erysipelas are not bacilli, but minute globular bodies (cocci) which stick together in rows, like beads; and the cause of cholera is a tiny comma-shaped bacterium. While, again, some microbes gain access to the blood, and thus by their marvellous powers of multiplication spread throughout the whole body, others remain at the point of inoculation, and yet set up profound disturbances in the system generally which ultimately end in death.

The last-mentioned fact, that the organisms themselves may be restricted to one point, while their evil effects may extend throughout the body, suggests that during their life they give off poisonous substances to which, rather than to the bacteria themselves, the diseases are due. This has repeatedly been proved to be the case. Here, again, anthrax furnishes an instructive example. It has been found possible to prepare from artificial cultures of the anthrax bacillus an intensely poisonous substance, which is nevertheless free from the bacteria; and this poison or *toxin* of anthrax induces, if injected into the blood of an animal, all the characteristic symptoms of the disease. Nor is this all. The strength of the toxin can be so regulated that while it is insufficient to cause death, it protects the animal against future attacks.

The theory which at present best explains these remarkable facts is that the toxins stimulate certain cells of the body to manufacture substances which neutralise them. These toxin-destroying substances are called *antitoxins*. Once the cells have got into the habit, so to speak, of producing antitoxins, they continue the work, and lay in a stock which is sufficient to promptly render useless the poison-armoury of the particular race of bacteria, should these again invade the territory.

The fact that the terrible zymotic diseases are due to blood-poisoning by toxins, and the possibility that for every toxin there is a corresponding antitoxin—in other words, that every disease produces its own antidote—which may yet be discovered and isolated, are sufficient to explain the tireless enthusiasm with which bacteriologists have of late years carried on their researches. Marked success has in many cases attended their efforts, and the manufacture of certain antitoxins is now carried on upon a somewhat large scale. The antitoxin of diphtheria, for example, is regularly prepared by a large German firm, and sent out to all parts of the world. The bacilli of the disease are first grown in specially prepared broth for about a month, by which time the fluid has become strongly impregnated with the poisonous toxin. The bacteria are filtered off, the clear solution obtained containing the toxin. This is then injected into horses in gradually increasing doses, until the animals can withstand a large quantity without inconvenience. Then after a few days' rest they are bled from the jugular vein. The whole operation is so carried out that the horses suffer practically no pain whatever, and very little injury to their general health. The blood is allowed to clot, and the clear fluid (serum) which rises to the top contains the antitoxin, and is hence known as anti-diphtheritic serum. It is now injected, in doses varying with the severity of the disease, into patients suffering from diphtheria. As a result of the treatment the mortality from this disease has been greatly lessened. Antitoxins have also been prepared for protection against and treatment of various other diseases, including typhoid, tetanus (lockjaw), plague, hydrophobia, and snake-poisoning. A few years ago there seemed to be grounds for believing that a cure for consumption had been discovered. The anticipations were, unfortunately, not realised; but the extract of "tuberculin," which it was hoped would rid humanity of its greatest scourge, forms a means of identifying tuberculous cows, and thus of removing one source of the disease.

The indictment against these low forms of life is a terrible one. Disease and dirt are, however, closely connected, and the introduction of better sanitary conditions will of necessity exterminate many diseases. As a rule, only those in a low state of health need fear these minute foes, for they are in nearly every case unsuccessful against vigorous constitutions. The various fluids of the healthy body have a distinctly injurious effect upon malignant bacteria, and it has recently been found that there are in our bodies certain wandering cells which in health act as policemen, promptly seizing and devouring the harmful microbes which do gain access to the system. The tonsils, for example, are crowded with these guardian cells.

The fact that during the progress of a disease the blood acquires properties inimical to the growth of the bacteria is very marked in the case of typhoid, and affords a means of diagnosing the disease. If we examine microscopically a drop of broth containing a young culture of the typhoid bacillus, we see the deadly plants darting and wriggling about the field in all directions. On diluting the drop with healthy blood-serum, no loss of activity is to be seen, but if the added serum is that of a patient suffering from typhoid, the movements slow down, and the bacilli seem as if paralysed. They collect in separate clumps, strongly suggesting different swarms of midges, and in a minute or two all is over. The bacteria are dead. The sight is, in its way, as striking as anything I have seen. It irresistibly brings up before the imagination the fierce struggle which goes on when disease-germs invade the body. Should they escape arrest by the "policeman-cells," they begin their deadly work, but all the reserve forces of the invaded country are called out. The intruders have first to fight against the healthy fluids of the body. If these are unsuccessful the bacteria live and multiply and give off their poisons. Immediately, however, the body responds and brings forward a supply of antitoxins. Then it is war to the knife. If the bacteria can produce toxins faster than the body can supply antitoxins, they win, and the patient sinks. The only hope is that, before general collapse has gone too far, a timely injection of the required antitoxin may put the enemy to rout.

The possibility of the last resource is due to the labours of such men as Pasteur, Lister, Koch, and their followers. They have shown that we have to fight for our lives against enemies, unimaginably small, but present everywhere and in countless myriads; but they have also been able to classify the foes into races and nations, to discover their various methods of attack, and in many cases to forge weapons by which these attacks may be foiled. The work is only in its infancy, but there is every reason to believe that its ultimate achievements will do more for the well-being of mankind than any other nineteenth-century discovery.

Conducted by M. I. Cross.

MICROSCOPIC VISION.—A paper of unusual interest entitled "An examination of the Abbe Diffraction Theory of the Microscope," was submitted for the consideration of the Royal Microscopical Society by Mr. J. W. Gordon, at the meeting held on June 19th last. It was sought to demonstrate that many of the experiments on which the Abbe theory is based were fallacious and incorrectly interpreted, and new ideas concerning the formation of the microscopic image were given.

It would be impossible, in the space at my disposal, to give even a brief *resumé* of the paper, for it will occupy probably fifty pages of the Society's journal, added to which I have not an advance copy of it before me, and only had an opportunity of examining it for a short time during the few days it was at my disposal. To do it justice, it will require to be read with consideration, and the experiments described actually worked out.

A paper of this description is of immense value, because it brings prominently before present-day microscopists straightforward statements which each can for himself verify or disprove, and, by comparing them with Abbe's experiments, gain considerable information on this interesting subject. The matter will surely give rise to discussion, and it is to be hoped that a tangible result may follow.

So far as the Abbe theory is concerned, it has to be borne in mind that Abbe's original papers were written more especially for those who had the benefit of a German University training in physics, and the actual experiments which Mr. Gordon in his paper seeks to disprove in some degree were intended, not as a complete proof of his theory, but as ocular demonstrations of some of his statements such as would appeal to those who had not had such training.

It has to be remembered further that the whole of Abbe's experiments are based on the assumption that the light used is parallel from a distant source, and directly the illuminant is brought near, as is the case in ordinary microscopical work where a lamp or a sub-stage condenser is used in focus, the whole circumstances are changed and the experiments cease to convince.

The publication of the paper will be awaited with interest, for it has awakened a doubt in some minds as to whether the microscopical image that is really utilized is influenced more by effects behind the objective produced by its aperture, than by diffraction effects in the object under examination. Under modern conditions of working where a condenser yielding a large aplanatic cone is used the condition of a self-luminous object is practically realised, for in such a case each point of the flame reaches one conjugate point in the flame image, and if that flame image is brought into correspondence with the object, each part of the lamp flame lights one point of the object. All the points are separately illuminated and are therefore not capable of interference in a very marked degree (although as a matter of fact there is slight interference), hence the value of our modern wide aplanatic cones of illumination.

PRESERVING AND MOUNTING MOSQUITOES.—Some time has elapsed since the connection between mosquitoes and malarial fever was established, yet satisfactory specimens of the former have reached England in very small numbers although medical men and others who are interested in the matter have constantly wished to obtain them.

The reasons are that the unmounted specimens are not put up in suitable preservative medium for travelling, or if they are mounted, sufficient care has not been exercised in the process. Several methods have been published in medical papers on the subject of preserving mosquitoes, but none of them are really satisfactory ones. The following will be found to answer the purpose:—

To send unmounted mosquitoes by post they should be preserved in dilute alcohol, two parts of rectified spirit to one part of water. Too many should not be put into one bottle or they become entangled and broken.

To make permanent mounts, dilute glycerine, say one part glycerine to two parts water, in a shallow cell will be found best. The following is the process:—

(1) Remove the dilute alcohol and soak in water until all trace of the spirit is removed.

(2) Soak in dilute glycerine for about twelve hours.

(3) Make cell, and when dry fill up with dilute glycerine and carefully place the specimens in it and apply the cover glass. Should the mosquito be too opaque after soaking in water, place it in a strong solution of carbolic acid for a few hours, and when transparent wash in water, then place in dilute glycerine.

PORTABLE MICROSCOPES.—At this season of the year when so many microscopists are travelling in search of health and pleasure, attention may be directed to a note on this subject in the April number of the *Journal of the Quekett Microscopical Club*.

It has often been remarked that effects can be obtained with large microscopes which cannot be secured with those of smaller size, and the home-worker invariably chooses a model of such large proportions as to render it unfit and inconvenient for carrying on short trips and holidays.

The provision of a companion microscope of small size but yet of a thoroughly serviceable character becomes very desirable,

XUM

and hours during holiday time which might otherwise be dull and wearisome, could be rendered profitable and enjoyable if a microscope were available.

The special microscopes to which attention is directed are :—

The Diagnostic Microscope by C. Baker, made at the suggestion of Surgeon-Major Ronald Ross, for the diagnosis of malarial fever, etc.

The American Portable Microscope by Bausch & Lomb, of Rochester, New York, the London agents for whom are Messrs. Staley & Co., Aldermanbury.

The Portable Continental and the Portable Star Microscopes by R. & J. Beck.

The Improved Clinical Microscopes by Swift & Son.

The Portable Microscope by Watson & Sons.

The above is practically a complete list of the portable microscopes that are made, excepting only a new one by Leitz. All of them have their points of advantage, either in weight, size, completeness of mechanical fittings, or price. The makers' catalogues will give full particulars.

In passing I feel bound to give special mention to the very neat and ingeniously made instrument by Swift & Son, referred to in the above list. It exactly fits my idea of a portable microscope.

NOTE ON EXAMINATION OF BLOOD.—A microscopical examination of a stained specimen of pathological blood implies a comparison with the appearance of normal blood when subjected to the same staining process. The experienced observer unconsciously makes use of his mental picture of the normal specimen in doing this work, and to him it is sufficient. In fixing and staining blood-spreads, however, a slight variation in technique may produce a decided difference in results, consequently those who have had comparatively little experience in such work will find it difficult to secure uniform results without a considerable laboratory equipment. In preparing pathological specimens in such cases a spread of normal blood may, at the same time, be subjected to the same technique and mounted on the slide with the pathological specimen, making exact and reliable comparison a very easy matter. Dried blood-spreads can be kept indefinitely, so a supply of normal specimens can easily be held in constant readiness for use.

NOTES AND QUERIES.

E. A. Jones.—I am sorry I cannot direct you to a source for Palæolithic flint implements, but if you were to communicate with Mr. T. Russell, of 78, Newgate Street, he would no doubt be able to put you in the way of obtaining them.

W. P. Williams.—A microscope suitable for general purposes and for the study of rocks and minerals need not be of special construction. It should have a stage that rotates concentrically, and this ought to be provided with screws so that it could be centred to any objective, or alternatively, a nosepiece with centering screws to attach to the lower end of the microscope tube and receive the objectives. You would need a polariscope; the polariser should have its rotating circle divided and a condenser system attachable over the prism to come flush with the surface of the stage. If you already have a substage condenser of large aperture, the polariser could be arranged to work with that. The analyzer would probably be found most useful if mounted over the eyepiece, and this also could have a divided circle attached to it. Extra fittings for petrology, such as a calcspar plate, Bertrand's lens, etc., would be applicable to an ordinary microscope equipped as above. If I can aid you further I shall be glad to do so.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office, 326, High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

NAKED-EYE COMETS.—These objects certainly appear more often than is generally supposed, but the circumstances are unfavourable and the apparitions brief. A conspicuous comet is rarely presented under the best conditions, but when these occur, the spectacle is long remembered as one of special interest. Among those comets which were well exhibited from an observational point of view may be instanced Donati's 1858, Coggia's 1874, Tebbutt's 1881, &c. Certain other fine comets were seen by few persons, and have now almost entirely passed out of memory owing to the difficulties which attended their observation. On an average, a comet is visible to the naked eye annually, for since the beginning of 1880 more than 20 of these objects have been recorded, the list being as follows :—

Year.	Month.	Comet.
1880	February	Great southern comet, tail 40°.
1880	October	Hartwig.
1881	June-September ...	Tebbutt, fine comet, tail 15°.
1881	July-August ...	Schaeberle, tail 10°.
1882	May-June	Wells.
1882–3	October-February ...	Great comet, tail 22°.
1883–4	November-January	Pons (1812).
1886	April	Fabry.
1886	May	Barnard.
1886	November-December	Barnard.
1887	January	Great southern comet, tail 35°.
1888	April-May	Sawerthal.
1889	July	Davidson.
1892	April-May	Swift, tail 20°.
1892	November	Holmes.
1893	July	Quenissett.
1893	October	Brooks.
1894	April-May	Gale.
1895	November-December	Perrine.
1899	March-May	Swift.
1901	April-May	Great southern comet, tail 15°.

The table might be increased by the addition of several other comets which were just visible to the naked eye, but in the historical records of these bodies details are not always given on this point.

THE GREAT SOUTHERN COMET.—This object has now passed beyond the reach of the most powerful telescopes. There seems, however, a possibility that it may be re-detected in the early autumn, though the prospect is not an inviting one, the comet being situated at a considerable distance from the earth.

COMET GALE (1894, II.).—Definitive elements have been computed by Mr. H. A. Peck, from more than 500 observations extending over the interval of 141 days, from April 2 to August 21. The orbit proves to be elliptical with a period of 1143 years. The elements agree very well with those derived by the Rev. Dr. Roseby, from observations during 78 days which indicated a period of 1001 years.

ENCKE'S COMET.—This interesting object returns to perihelion in September, 1901, but the conditions will not be favourable, and the comet is not likely to be much observed. At the time of its passage through perihelion it will be on the opposite side of the sun to the earth. This comet was first discovered by Méchain, at Paris, in 1786, and at later returns by Miss Caroline Herschel, in 1795, by Thulis, in 1805, and by Pons, in 1818. Encke soon afterwards determined its real orbit and predicted its return in 1822, which duly occurred. Since 1822 the comet has made 21 returns, each of which has been observed.

AUGUST METEORS.—The moon will interfere with observation early in the month, but meteors are usually so numerous at this epoch that the observer may gather plenty of materials even in a bright sky. At the time of the maximum (August 11), and during the later stages of the shower, the circumstances will be more favourable, and with fine weather the display may be well observed. The paths of all the brighter meteors seen should be recorded, and especially those which belong to the minor streams. In every case it is desirable that the *direction of flight* should be noted with the utmost care and precision, for it is entirely upon this feature that the accuracy of the radiant point depends. The visible duration of the Perseid shower probably extends to the end of the third week in August, but it is extremely difficult to assign the definite limits. In 1900, the writer at Bristol saw a radiant of swift, streak-leaving meteors on August 22 at 59° + 59°, which corresponds with the probable place of the Perseid radiant on that date, but there is a persistent shower of Camelopardids from the same apparent position during August, and it is therefore doubtful whether the meteors annually seen on about August 21 and 22 are really late members of the great Perseid display. Observations should be made between August 17 and 22 with a view to obtain more evidence on the point.

BRIGHT METEOR.—On July 8 a meteor, moving very slowly and with an extremely long path, was observed at Torquay by Miss L. M. Milner, and at Eastbourne by Mr. H. M. Whitley. At Torquay the object passed from α–β Capricorni to Aries, while at Eastbourne the observed course was from μ Serpentis to Cor Caroli. The radiant was at 253° − 24°, so that it belonged to the June–July Scorpiids. At Eastbourne the meteor was as bright as Jupiter, and its duration was 10 seconds. It fell from heights of 53 to 26 miles, and its velocity was

about 12 miles per second. Crossing the English Channel the meteor passed near the eastern extremity of the Isle of Wight, and directing its flight to N.N.E., finally disappeared over a point near Godalming. The shower of summer Scorpiids to which the meteor belonged, is quite a remarkable one, and special attention to it was called by the writer in *Astronomische Nachrichten*, No. 3719.

THE FACE OF THE SKY FOR AUGUST.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 4.25, and sets at 7.47; on the 31st he rises at 5.13, and sets at 6.47. The disc should be carefully watched for spots.

THE MOON.—The moon will enter last quarter on the 7th at 8.2 A.M., will be new on the 14th at 8.28 A.M., will enter first quarter on the 22nd at 7.52 A.M., and will be full on the 29th at 8.21 P.M. The following are the occultations visible at Greenwich during the month:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Aug. 3	D.M.−3°5539	6·3	12.58 A.M.	45	58	2.8 A.M.	260	261	18 4
,, 5	δ Piscium	4·6	2.39 A.M.	84	99	3.47 A.M.	224	225	20 5
,, 6	29 Arietis	6·5	10.51 P.M.	57	95	11.42 P.M.	269	309	22 1
,, 7	D.M.+17°564	6·5	11.11 P.M.	26	62	11.43 P.M.	308	347	23 1
,, 24	B.A.C. 6098	6·5	8.47 P.M.	44	35	9.51 P.M.	300	280	10 13
,, 29	c^1 Capricorni	5·2	12.54 A.M.	85	68	1.59 A.M.	224	199	14 17
,, 30	κ Aquarii	5·5	12.29 A.M.	28	23	1.29 A.M.	278	262	16 16

THE PLANETS.—Mercury is a morning star throughout the greater part of the month, being at greatest westerly elongation of 19° 23′ on the 2nd, and in superior conjunction on the 27th.

Venus is an evening star, setting about an hour later than the sun throughout the month, and therefore not conveniently situated for naked-eye observation. On the 15th the illuminated part of the disc is 0·873, and the apparent diameter 11″·8.

Mars is still an evening star, setting about 9.42 P.M. on the 1st, and about 8.15 P.M. on the 31st. The path of the planet is from near γ Virginis to near the eastern boundary of Virgo, passing a little north of Spica on the 18th. The apparent diameter diminishes from 5″·4 to 5″·0 during the month.

Jupiter will remain a very conspicuous object in the evening sky in spite of his low altitude. He is on the meridian at 9.40 P.M. on the 1st, and at 7.37 P.M. on the 31st, the apparent polar diameter diminishing from 42″·2 to 39″·0. The path is westerly, through Sagittarius, until the 30th, when it will be stationary. The more interesting satellite phenomena at convenient times are as follows:—

		H.	M.
1st.—	I. Tr. E.	8	13
	I. Sh. E.	8	58
5th.—	II. Sh. I.	9	15
	II. Tr. E.	10	24
7th.—	I. Oc. D.	10	35
8th.—	I. Tr. I.	7	43
	I. Sh. I.	8	35
	I. Tr. E.	10	0
	III. Sh. E.	10	29
	I. Sh. E.	10	53
9th.—	I. Ec. R.	8	10·6
	IV. Ec. R.	9	12·1
12th.—	II. Tr. I.	9	56
	II. Sh. I.	11	50
14th.—	II. Ec. R.	8	52·5
15th.—	III. Tr. I.	7	21
	I. Tr. I.	9	31
	III. Tr. E.	10	26
15th.—	I. Sh. I.	10	30
	III. Sh. I.	11	19
	I. Tr. E.	11	48
16th.—	I. Ec. R.	10	5·5
17th.—	I. Sh. E.	7	17
	IV. Tr. E.	8	32
23rd.—	I. Oc. D.	8	39
	I. Ec. R.	12	0·4
24th.—	I. Tr. E.	8	5
	I. Sh. E.	9	12
26th.—	III. Ec. R.	8	38·4
28th.—	II. Oc. D.	8	59
30th.—	II. Sh. E.	9	9
	I. Oc. D.	10	29
31st.—	I. Tr. I.	7	39
	I. Sh. I.	8	50
	I. Tr. E.	9	56
	I. Sh. E.	11	8

Saturn is also in Sagittarius, a little to the east of Jupiter. He crosses the meridian on the 1st at 10.9 P.M., and on the 31st at 8.6 P.M. On the 13th the apparent diameter of the planet will be 16″·6, and the major and minor axes of the outer ring respectively 41″·7 and 17″·9. The northern side of the ring is presented towards the earth.

Uranus remains in the most southerly part of Ophiuchus, nearly midway between Antares and η Ophiuchi. The planet crosses the meridian on the 1st at 8.8 P.M., and on the 31st at 6.9 P.M.

Neptune cannot be observed on account of his apparent proximity to the sun.

THE STARS.—About 10 P.M., at the beginning of the month, Perseus and Cassiopeia will be in the north-east; Pegasus, Andromeda, Aries and Pisces towards the east; Aquarius and Capricornus in the south-east; Cygnus and Lyra nearly overhead; Aquila and Sagittarius in the south; Hercules and Ophiuchus towards the south-west; Corona and Boötes in the west; and Ursa Major in the north-west.

Minima of Algol will occur on the 9th at 9.4 P.M., and on the 29th at 10.47 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of July Problems.

No. 1.

(A. H. Williams.)

1. B to B8, and mates next move.

No. 2.

(B. G. Laws.)

Key-move.—1. Kt to K8.

If 1. . . K × R, 2. Q to Kt3, etc.
1. . . B × R, 2. Q to R6, etc.
1. . . P moves, etc. 2. Kt to B6ch, etc.

[The above was the composer's intention, but the problem admits of three other solutions, by 1. R to K7, 1. R to Q4ch, and 1. Q to R6.]

Six points have been scored this month by W. Nash, W. H. S. M., J. Baddeley, S. G. Luckcock, G. Groom, J. T. Blakemore, W. Jay, G. W. Middleton, W. de P. Crousaz, F. Dennis, G. W., V. H. Macmeikan, C. Johnston, A. C. Challenger, J. E. Broadbent.

Five points by H. Le Jeune, G. A. Forde (Capt.), H. S. Brandreth, Eugene Henry, H. Boyes, C. F. P., C. C. Massey.

Four points by Alpha.

Two points by A. E. Whitehouse.

C. C. Massey.—I cannot follow your reasoning as to Mr. Anderson's problem. After 1. P × B (becoming a Queen), P to R8 (becoming a Knight), it is just because the Black Knight is unable to move that stalemate will result; supposing, that is, that White makes any attempt to mate.

Alpha.—1. B to K7 is answered by 1. . . . Q to QBsq.

G. W. Middleton.—Two keys score full points, whether the composer's intention be discovered or not.

H. Wood.—The conditions of your 8 Pawns problem are given below.

N. M. Gibbins.—Many thanks for the problem; it is marked for publication in the autumn. There was no need for the re-introduction: I remember your former problem and have seen others of your composition.

British Chess Company.—Regret that it is impossible to arrange a correspondence match on the lines suggested.

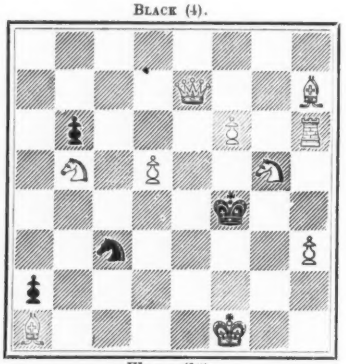
Mr. H. Wood, of Bolton, sends the following curiosity. Black is to have all his pieces and Pawns arranged in their proper order, as at the commencement of a game. White is to have a King and Pawns only, the former to be on his own square and the Pawns to be placed where he likes. How many White Pawns will be required, and where must they be placed, so that Black, even with the move, is mated in five moves or less? Correct solutions will be acknowledged, but the puzzle will of course not count in the solution tourney.

PROBLEMS.

No. 1.

By W. S. Branch.

BLACK (4).



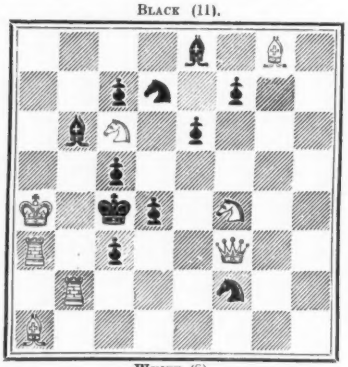
WHITE (10).

White mates in two moves.

No. 2.

By W. Clugston (Belfast).

BLACK (11).



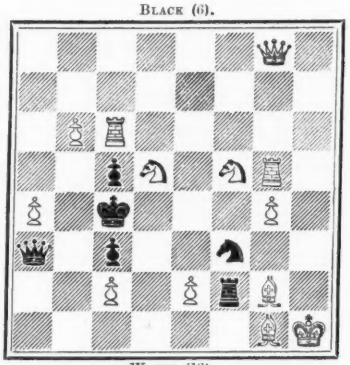
WHITE (8).

White mates in two moves.

No. 3.

By W. H. Gundry (Exeter).

BLACK (6).



WHITE (13).

White mates in two moves.

CHESS INTELLIGENCE.

Three counties are left in for the deciding round of the Southern Championship, viz., Essex, Surrey and Gloucester. In playing off the ties Essex have defeated Surrey, as stated last month, but lost to Gloucestershire by 9½ to 6½. Should Gloucestershire succeed in defeating or even drawing with Surrey, they will of course win the championship; but should Surrey win the match, the county which has scored most won games in its two deciding matches, drawn games being left out of the question, will be declared the winner.

We have to record, as a very unusual event, that the Scottish championship has not been won by Mr. D. Y. Mills. In the tournament of the Scottish Association, he tied for first place with Dr. Macdonald, both players scoring 6 games out of 7. In playing off the tie, it was agreed that one game only should be played; Mr. Mills was a Pawn ahead in the end game, but made a blunder which lost a piece and the match.

The principal event of the Kent Chess Congress, held at Folkestone during the Whitsuntide holidays, was an open tournament for first-class amateurs. The players were divided into two sections, Mr. Atkins winning in Section A, Mr. Serrailier being second, and Mr. J. H. Blake in B, after a tie with Mr. Tattersall. In playing off, Messrs Atkins and Blake drew their game and divided the prizes. Messrs. Mortimer, Wainwright and Lowe were among the competitors.

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